GUTHRIE

ON

WOUNDS AND INJURIES

OF ARTERIES.

Edward Akers,
Halifax.

Edward Akers,

August 1846.

ON

WOUNDS AND INJURIES

OF THE

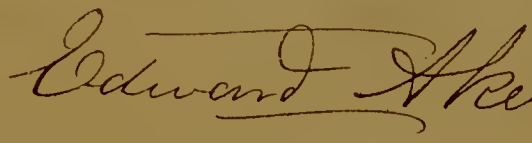
ARTERIES OF THE HUMAN BODY;

WITH THE

TREATMENT AND OPERATIONS

REQUIRED FOR THEIR CURE.

ILLUSTRATED BY 130 CASES, SELECTED FROM THE RECORDS OF THE PRACTICE OF THE MOST CELEBRATED SURGEONS IN EUROPE AND AMERICA, WITH THE CRITICAL REMARKS OF THE AUTHOR ON EACH.



By G. J. GUTHRIE, F.R.S.

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The following Lectures were given for the purpose of showing the erroneous nature of the opinions entertained by many Surgeons, even of the present day, with respect to the practice to be adopted in cases of Wounds and Injuries of Arteries; and with the view of demonstrating and firmly establishing the fact, that the practice recommended and generally pursued during the latter part of the war in Portugal, Spain, France, and the Netherlands, is the only one which can be followed with safety and success. It will be a consolation to those who labour in the great work of diminishing the ills to which mankind is subjected, to know, that some good has in this instance, resulted from evil; that the knowledge which has been thus derived from one of the most sanguinary, distressing, and eventful struggles recorded in modern history, is and will be pre-eminently useful in saving the lives of many for ages yet to come.

4, Berkeley Street, Berkeley Square.
July 14th, 1846.

LECTURES

ON SOME OF THE MORE

IMPORTANT POINTS IN SURGERY.

PART I.

ON WOUNDS AND INJURIES OF ARTERIES,

WITH THE

OPERATIONS REQUIRED FOR THEIR CURE.

INTRODUCTORY LECTURE.

Gentlemen,—I have long promised to write one or two more books in connection with the many different points in surgery which I have already noticed. My record of the "Surgery of the Peninsular War," for instance, is incomplete. That part which relates to the injuries of the chest, the abdomen, and the pelvis, is scarcely known except to those who formerly attended my lectures; and the consequence is, that many students are unacquainted with the improvements introduced into the treatment of them during that war, although thirty years have since passed away. Many of the gentlemen who come before me at the Court of Examiners of the College of Surgeons are exceedingly ill-informed on these subjects, although they have fairly studied many others. Some do not even know when a man is stabbed on the right side of the chest, whether he should lie on that side, or on the other, or on his back, and even if they should answer correctly, it is by no means uncommon for them not to be able to give a reason for the selection. If they seldom know this, the very first step to be taken in the treatment of these injuries, it may readily be inferred how little likely it is, that they should know other and succeeding parts more accurately. I can safely say that scarcely one student I have examined, in the eighteen years I have been an examiner, has been able to tell me the proper treatment to be pursued with regard to an incised wound in the chest, into which the lung had protruded, even if he were able to describe what ought to be done when it had not. When I was first elected into the Council of the College of Surgeons, an honour conferred upon me at an earlier period than had ever befallen any other person, not on account of any merits of my own, but from the reflection of those of others which I had been the means of placing on record, the elderly gentlemen were, it is said, but little acquainted with these injuries. Sir Peter insisted that every man should be bled, because he had the misfortune to be stabbed—Sir Roger, that he should be thoroughly physicked, in order to allow of a free descent of his diaphragm—and Sir Richard was for keeping his wound open, that the secretions might readily flow out, until the proper time for duly closing it should arrive. If the bleedare, the purgare, and the clysterisare system did not suffice, it was admitted that there was nothing better to be done than to rebleedare, repurgare, and reclysterisare, as Moliere and his associates had recommended to be done before. The grinders of the present day instruct their aspirants to close such wounds without delay, to eschew calomel and jalap as incompatible with the absolute rest such cases require, even if the diaphragm should not descend with perfect freedom, and teach them not to bleed in expectancy.

Wounds of the abdomen were not in more fortunate consideration. The elder surgeons brought the edges of a cut in the wall of the belly of three inches in length, into some sort of apposition by two stitches of several good thick threads, introduced at equal distances through the muscles down to the peritoneum, but woe to the man who thought of touching this inner lining. Having been thus stitched up, which was of itself enough to aid him out of this world—if the accident itself had not been sufficient—he was then to be thoroughly well physicked, and bled ad libitum.

An accomplished grinder now disapproves as much of a stitch in a muscle as the surgeons of old did of one in the peritoneum, and as he crams in

turn his expecting students with the peculiar doctrines of Mr. A. or B., he teaches them to sew up the skins, and the skins only of their patients, exactly as their mothers would do a hole in their best pocket-handkerchiefs. He inveighs against salts and senna, and protests that they do not accord with that state of quiescence which can alone save the patient.

Surgery has followed in the wake of other things, and has yielded to the dictates of experience, founded on observation. It has been, however, somewhat slower in its progress than other matters of science which are commonly valued at a higher rate, than the art of saving life.

Gentlemen who have accidentally seen one or two cases of wounds of the chest, have sometimes thought themselves at liberty to lay down what they call principles to be followed in all cases of the kind; and it has been a matter of surprise to many to find their precepts doubted by those who have had greater opportunities for observation than themselves. Few, like my late learned friend, the professor of military surgery in Edinburgh, have the candour to acknowledge the erroneous nature of the opinions they had been taught, or the honesty to avow that they were altered. I think it was a Whig Government that created, very many years ago, the office of professor of military surgery in the University of Edinburgh, to reward the services of a zealous medical supporter, resting their defence of the new appointment upon the grounds that the individual in question, being a civilian who had never seen a shot fired, nor any sort of military service, was at least open to conviction and improvement—that he was a sort of tabula rasa, as far as experience was concerned. The professor was really a learned and a most honourable man, and an able surgeon, and taught what he did know in a manner which gained him universal approbation. Nevertheless, there were some things he did not profess to know too well; and when the battle of Waterloo was fought, he was glad to avail himself of such an opportunity of acquiring information, and hastened to Brussels, with a full recollection in his mind of Mr. J. Bell's work on Wounds of the Chest, which he had particularly studied and admired. One part of this treatise is elaborately written; the description of the inflation of the whole of the cellular membrane of the body, which ensues after a gun-shot wound of the chest, is so truly graphic, so beautifully described, that it is even now frequently referred to as an admirable specimen of surgical writing. An unfortunate man, lying with a musket-ball in his chest, and gradually swelling up, until he parodies in appearance the ambitious frog in the fable, naturally attracted the sympathy, and lived in the recollection of every one. When the learned professor reached Brussels, his first question to me was, "Did you see many of the cases of emphysema so well described by Mr. John Bell in his admirable book on wounds, when you were in the Peninsula? How many are there here? You must have heard of every good case—do show me some of them." I replied, with all becoming gravity, that the last case I had seen of general emphysema was at Tarbes, after the skirmish which took place in front of that town. A poor creature was brought into the square before my door, one morning, apparently dead. He was carried by three men, with long white sticks in their hands, followed by a fourth with a pair of bellows. The three first had scarcely put him down, when to my astonishment they began to strike him smartly with the sticks, and the fourth, before I could get down to interfere in his behalf, had cut a hole in his skin, near the bottom of his back, into which he introduced the muzzle of the bellows, and in an incredibly short space of time had blown him up to twice his natural size. The incredulity shown by the worthy doctor at this relation of my case rendered it necessary for me to explain that the patient was a calf, and that the four butcher boys had in three minutes fairly outdone John Bell. The professor and the friends who accompanied him declared I was laughing at them, and could scarcely credit my assurance that I had never seen such cases as the late Mr. J. Bell had described, and that they would nowhere find them, except in Mr. John Bell's book. The doctor was, however, easily satisfied they were not to be found in Brussels. He soon understood that a musket-ball makes too large a hole to admit of such a thing taking place, although it possibly may occur from a stab, or small hole, which may not prevent the closing of the external opening, whilst the inner wound into the cavity of the chest, communicating with the lung, remains pervious. The learned professor smiled on hearing this explanation, and said, "I am afraid I have much to learn, and more to unteach"—an acknowledgment which did him honour. He remained at Brussels long enough to make an epitome of all the interesting cases he saw, which he published on his return, and by it gained great credit. The result to himself was not bad, and there is certainly no ill-will in the story, although perhaps there may be some little satire in telling it. The Tories were in office on his return, and were determined not to be outdone by the Whigs, in rewarding a meritorious servant. They thought that as their political opponents had made him a professor when he knew but little of the subject he was to teach, something ought to be done for him when he had well qualified himself for the office. They therefore made him a staff-surgeon, the full pay of which he enjoyed for a long time, and the half pay until his decease. You may learn from this anecdote, that a good surgeon and a zealous politician are sometimes not incompatible nor disadvantageous qualifications.

There are few occupations more troublesome than printing or publishing books when the stimulus of necessity is wanting, and when the subject precludes all hope of pecuniary profit. My publishers, for instance, persuade me to pay for the paper and printing of a book, as a first expense, and then to allow them 10 per cent. commission for taking care

of it, which, together with 30 per cent. allowance to the retailing booksellers, with the additional advantage of receiving thirteen as twelve, make 50 per cent., leaving 50 to pay for paper, printing, and advertisements. Direct profit is not therefore to be thought of from a book on wounds, &c.; the indirect profit, it is said, might be incalculable, if people were not so seldom shot or run through the body as to indispose them to buy books which treat of such matters. I willingly pay for a book that people will buy on more common complaints, or accidents in which they may be immediately interested; but I have been careless of doing so for those which are not likely to pay either directly or indirectly. I now content myself by allowing my opinions to appear before the public through the medium of such of the weekly medical journals as may please to publish them.

The treatment of wounded arteries is not better understood by students in general. They can all answer that a ligature ought to be placed above and below the wound in the artery, or on both of its ends when divided; but try them on the means to be adopted in a punctured wound of the axillary artery, or of the femoral, or in a case of wound of the calf of the leg, in which it is doubtful whether one or both of the arteries are injured, and they are lost. If they fly for assistance to Mr. Hunter's theory for the cure of diseased arteries, they will find a method of proceeding which is never successful when put in practice for a wounded artery, or at least so seldom successful as to form only an exception to the general principle already mentioned, and which can never be departed from without imminent danger to the limb, if not to the life of the patient. It is not less extraordinary than true that different principles, as they are called, are taught in different schools of surgery in London, and my examinations on these points frequently become courses of instruction, instead of inquiry, and I am in consequence obliged to exercise a leniency, when about to pronounce sentence of approval or rejection, which often materially interferes with my sense of public duty.

Anatomy has its little differences as well as surgery. The learned professors of school No. 1 teach that a femoral hernia descends into the sheath of the femoral vessels. The no less learned professors of school No. 2 declare that it is on the contrary, projected against the part only which is going to form the sheath, and that it descends in a separate tunic of its own, by the side of, but distinct altogether from, the sheath of the vessels. With these gentlemen I concur in opinion. The very able professors of school No. 3 teach that this same femoral hernia comes out in the thigh at the saphenous opening. The equally able professors of school No. 4 declare that it has little or nothing to do with the saphenous opening; to which opinion I assent. The most perfect of grinders cannot get over this. He is obliged to beat two opposite opinions into the heads of his *élèves* in the morning, and two more in the afternoon, that he may be able more conveniently to cram them again all round with the whole four in the evening. How can this be settled? One of the medical bills lately introduced into Parliament, but which did not long remain there, provided for the establishment of a Council of Health, so called on account of its having nothing to do with the health of any one person whatever, but which name was possibly selected because no one could suspect that, to a body constituted under so unassuming—nay, benignant—a title, powers were to be granted of a more arbitrary and oppressive nature, more subversive of the rights and best interests of individuals than any which have been conveyed by any other act of Parliament. One of the clauses of this bill empowered this council, or medical inquisition, as it ought to have been called, to ascertain whether the examiners of the different colleges did their duty to the satisfaction of the council. If they had not done so, men of only ordinary minds might perhaps have thought it right to give authority to the council to admonish the examiners. The authors of this bill thought otherwise. They empowered the council to punish the students, to refuse them (although declared competent by the examiners) their authority to practice, without which they could not legally do so; and thus, in fact, to destitute them, to turn them out to starve, until the examiners should acknowledge their errors, and amend their ways. If any of these bills should re-appear, I will do my endeavour that a clause shall be inserted by which these anatomical differences may be quickly adjusted, and the provision to be made for this might be, "that until the professors can agree upon anatomical facts which admit of clear and easy demonstration, the students shall be annually whipped, at the end of each session"—one clause being a *pendant* to the other.

The war in the Peninsula terminating, it may be said, by the battle of Waterloo in Belgium, added much to the character of the British army, and to the military renown of the nation, whilst the miseries caused by, and attendant upon it, have led to the improvement of the art and science of surgery in a degree which neither could or would have been effected without them. My late friend, Sir Astley Cooper, took pleasure in declaring that the practice of that war had given to surgery its greatest impulse in the present century, and the admission showed an honesty and nobleness of disposition it would well have become others to have imitated.

Engaged from the first battle on the heights of Roliça, to the last of Toulouse, and subsequently at Waterloo, generally in the field, or in charge of a principal part of the wounded afterwards, there was no one who, from his labours or his opportunities, had a better right to take upon himself the humble office of recorder and historian of the surgery of that war. When I undertook this duty, thirty-one years ago, I laboured under one great defect, to say the least, which time has however removed. I was not twenty-nine years of age. I had wrung from the authorities at home the inspectorial rank I held by dint of hard work alone,

and I was afraid of giving offence to those I had distanced in the course by assuming anything to myself. Nothing, therefore, could be more humble and unassuming than the expression of my views in the first and second editions of my book on Gun-shot Wounds, and the Operations of Amputation. They were followed by so much change in the opinions of the profession on the points to which they adverted, that whilst few objected, and none refuted, some were not ashamed to appropriate an improvement or two as their own, and to sneer at what they were not equal to disprove, or to overturn. In 1827 I published the third or greatly enlarged edition of my treatise on Gun-shot Wounds, on Inflammation, on Erysipelas and Mortification, on Injuries of Nerves, and on Wounds of the Extremities requiring the great operations of amputation of the hip-joint, shoulder-joint, &c., with a preface, in which I *then* felt it right towards the medical officers of the army to claim for them the improvements they had introduced. It is as follows :—

When I printed the first edition of this work, in 1815, I stated, that it contained "many opinions in opposition to those received in common by the profession, and even now taught." I also said, that in publishing them I was desirous of making known "what had been the practice of the surgeons of the British army during the Peninsular war, and to preserve for them the credit of the improvements which they alone have introduced into the science and art of surgery, and particularly in the operative part, in which they have been eminently successful." In referring to my professional brethren that credit which was their due, I by no means wished to exonerate myself from any blame that might be attached to the practice recommended, for I was aware that some of these opinions were not common to the whole, and for those in particular, as well as for every one of them, I held myself responsible. I was contented to allow them to find their way as unobtrusively as possible into the world, satisfied they would stand the test of investigation, and be ultimately adopted as principles. In this I was not mistaken: they have not only been generally adopted, but pirated by some persons, and even advanced as something new by others, many years after I had published them. In order to put a stop to such proceedings I shall now enumerate those points in which surgery is indebted for its improvements to the medical department of the army and the practice of the Peninsular war; and in doing so I trust I shall redeem the pledge given to the medical officers of the different branches of the public service in the introductory lecture to my first course of lectures on surgery, in 1816, that I would always defend and maintain their right to the improvements they first suggested or made against all encroachment."

"Previously to the termination of the war in 1813, and the appearance of the first edition of this work, the opinions of Mr. Hunter on the powers and capabilities of the human constitution were invariably received. As general principles they did little mischief; but when they came to be acted upon, the results were not found to coincide with the principles from which they were deduced. When an injury had occurred to a person in health, rendering the loss of a limb necessary, he recommended that an operation should not be performed until after suppuration had been established, a period, probably, of six weeks, which, even if the patient survived, was often found to be too late to be serviceable."

"From the failure of this practice, the contrary one of immediate amputation, became gradually more general during the war, and at its close I not only advocated and established the propriety of it, but examined the reasoning on which Mr. Hunter's opinions were founded, and I trust have proved it defective. That it was so ought indeed to be presumed, when the facts were found to be opposed to the reasons."

"It was not, however, on the single point of amputation that this reasoning led to error, it embraced the whole subject of inflammation and its consequences, which I believe can only be consistently viewed on the principles regarding the human constitution which I have advanced. The variations in the nature and appearances of erysipelas may through them be more easily comprehended, and the treatment of mortification more scientifically undertaken. The Baron Larrey has shown, in opposition to the received opinions of the schools, that in gangrene from wounds, amputation might occasionally be resorted to with success during its progress; but he did not explain that this was entirely dependent on the circumstance of its being local. The division I have made into constitutional and local mortification, and the practice I have indicated to be followed in the different species of gangrene, from whatever causes they may have originated, as dependent on this distinction, are improvements which many are inclined to adopt, without being aware to whom they are indebted for them. There is still, however, in some, an unaccountable slothfulness in neglecting all inquiry into this subject, whilst there is in others an obstinate adherence to the old practice, although unsuccessful."

"The practice of the Peninsular war led, however, to another important result in surgery; it dissipated that delusion which had so long obtained possession of the minds of surgeons of every description, 'that it was impossible to command the flow of blood through the great arteries.' I overturned at once this hypothesis—declared it to be visionary, and not only without foundation, but the reverse of fact. On the return of the medical officers of the army to London, in 1814, it was not a little amusing for them to hear teachers of surgery gravely informing their students that amputation at the shoulder-joint was a most formidable operation, on account of the impossibility of effectually preventing the flow of blood through the arteries; and when they did notice amputation of the hip-joint, it was only to declare it a murderous

operation. What is the state of things now? What has the short space of twelve years done for this branch of surgery? Why almost too much. The facility with which these operations can be performed, and the safety which attends them, has been shown, and all alarm has been banished from the minds of surgeons on these points. It is now to be feared that they may become unmindful of the precepts I have laid down demonstrative of *their necessity*, and recommend them to be performed when others less important might suffice."

"The practice of the Peninsular war was decisive on many other points. It overturned the application of the theory of aneurism to the treatment of wounded arteries, and my paper on wounded arteries, published in 1811 in the new *Medical and Physical Journal*, demonstrated the necessity which existed for performing the operation at the wounded part of the vessel, and not at a distance. It showed, what is not yet well understood by many, that in no case (and this is without exception) should one ligature above the wound in an artery be depended upon, but that another should be applied, if possible, below it."

"I have proved from official documents that the great dread entertained of secondary hemorrhage in gun-shot wounds was groundless, whilst the practice in all cases has been established on more certain principles than before."

These and many other minor points I do not think it necessary to notice. A careful examination of the books which existed at the commencement of the Peninsular war, and a comparison of them with the observations there made on the same subject will show in what part the alterations and improvements have taken place, whilst the work, from its continued reference to the different periods of the war, demonstrates the fact of the particular time at which each of them was established, if it does not mark that at which they originated"—June 18, 1827.

The experience of the last thirty years in London, during which time I have enjoyed a share, I fear beyond my deserts, of hospital and of private practice, has confirmed the accuracy of these statements, and although I trust some improvement will yet take place in many until they attain perfection, I shall not be disposed to abandon one of them until a superior degree of information on these points be shown, which at present I do not anticipate, but which I shall most gladly acknowledge.

There is not, in fact, one word in that preface which is not true. Since 1827 nearly all my old friends and fellow labourers have passed away. I am the more bound to protect their memories. There are none to be annoyed by any stories I may now tell, by any errors to which I may allude. They have long since expressed their sense of the services they were pleased to say I had rendered them by my records and lectures, in the kindest and most liberal manner, and although I have been careful to claim little as personal to myself in all I have written, or shall do in what I have yet to write, or to say, no one of them has disputed, nor will any of those who remain dispute any assumption I may make as to how much or how little is my own.

Professor of Anatomy and Surgery to the College of Surgeons during the four years ending in 1831, I published the principal part of the lectures I had delivered during that time: On the Diseases and Injuries of the Arteries of the Human Body; on the Operative Surgery of the Eye; on some Points connected with the Anatomy and Surgery of Femoral and Inguinal Hernia; on the Anatomy and Diseases of the Urinary and Sexual Organs. In 1833: Lectures on the Treatment of Compound and Gun-shot Fractures of the Extremities; on Excision of the Head of the Thigh-bone, the Arm-bone, and the Thigh-bone. In 1841, again Professor of Anatomy and Surgery to the College: on Injuries of the Head affecting the Brain. Very early I had recorded an improved method of Treatment of Syphilitic Diseases without Mercury, &c. Some of these books have gone through three editions, and most of them are out of print.

In the course of the lectures I am about to give in this and the ensuing year, I hope to be able to draw your attention to all the points I have hitherto omitted, and to advert to many of those I have noticed which appear to be of most importance. I shall begin with the injuries and wounds of arteries, including the operations required to their cure, with the hope of attracting the attention of surgeons and students more fully to the essential points to be observed in their treatment. These will be followed by an inquiry into the wounds and injuries of the chest, the abdomen, and the pelvis, with the operations required for breaking up, and for extracting a stone from the bladder.

It may be, in conclusion, some satisfaction to you to know, and it is not less satisfactory to me to declare, that none of the opinions I have advocated on behalf of my old friends, most of whom are no more, are disputed or disallowed by any of my colleagues of the Court of Examiners of the College of Surgeons, as far as I am at present aware. There is no practical point positively recommended which all of them have not admitted, and have required all students to acknowledge, up to the retirement of my old friend, Mr. White. That some of these opinions may hereafter be found capable of improvement, and requiring alteration, I am willing to admit. All I desire of you now is, that you will believe, until opportunities for observation shall occur, which may enable you seriously to doubt.

LECTURE I.

Wounds and injuries of arteries; Structure of arteries; External coat — Internal — Middle; Fourth coat of Haller and Malgaigne; Efforts of nature in healing wounds of arteries; Effects of small puncture; A large puncture; Case of puncture of the ulnar artery by a medical student in bleeding a friend; Case of a tailor of the 40th regiment after the siege of Badajos; Effects of division of a large artery to one-third or one-fourth of its circumference; Case of a wound of the carotid by an arrow; Mr. Chamberlaine's case; Case in St. George's Hospital of stab in the thigh; Effect of a transverse opening in an artery—in man, in horses, and dogs; Complete division of an artery; Insufficiency of experiments in ascertaining the processes by which hemorrhage is suppressed; Effects of complete division on arteries of small dimensions; Case of soldier whose arm was shot off at Ciudad Rodrigo; Case of soldier whose leg was carried away at Salamanca by a cannon-shot; Contraction of extremity of the wounded artery; Effect of pressure on surrounding parts on wounded arteries; Division of arteries in amputation at the hip-joint; Division of femoral high up in the thigh; Case of thigh torn off by a cannon-ball; Probable result to the artery in such a case; Case at Salamanca; Processes in a somewhat smaller artery; Hemorrhage from lower end of divided artery; Processes of nature for closing the lower end of a divided artery; Effect of the collateral circulation; Appearances in lower end of artery; Case of a serjeant of the 62nd regiment at Toulouse; Case of a soldier of the German heavy cavalry; Conclusions to be drawn from these facts.

Gentlemen,—In commencing our inquiries into the subject of wounds and injuries of arteries, and the treatment and operations required for their cure, I shall detain you for a moment on that of their structure. In Great Britain anatomists usually consider them as composed of three coats:—1. A strong, fibrous, interwoven, dense, unyielding, external tunic, firmer within than without, and of a greyish-white colour. It may be destroyed by pressure, but does not tear or separate under the application of a silken ligature; it is especially elastic and retractile. 2. A fibrous, contractile, or pseudo-muscular layer, of a yellowish-red colour—more developed in the smaller arteries—less coloured in the larger; its fibres are nearly circular, and united by others said to be oblique, or spiral; they are elastic to a certain extent, and eminently retractile and contractile. 3. A serous coat composed in the aorta of several layers. In the extremities it is a smooth and polished membrane, of a whitish-yellow colour, without fibres, soft and unctuous to the touch, of a dense, although partly transparent, structure, and readily torn in every direction by a slight degree of extension. These two last coats yield to, and are readily divided by a ligature applied to the artery with a moderate degree of force.

Baron Haller, and several of the later French anatomists, particularly Malgaigne, reckon the cellular substance which may be perceived in the aorta, but not in the pulmonary artery, between the middle and internal coats, as a fourth coat. They consider this part to be the principal seat of disease in arteries, and that to it the artery owes much of its elasticity. The structure of the external and the middle coats of an artery appears to be less dense in the female and in children than in the male, and although there is so general a resemblance between the arteries of man and of animals, as to render them apparently similar, their structure is not exactly alike. A second cellular coat, for instance, is found between the external and middle tunics in the ox. It has not been practicable to cause an aneurism in dogs, and the apparent similarity of these vessels, with reference to the effects which may result from injury or disease, cannot be depended upon; nor can any confidence be granted to the numerous experiments which have been very cruelly made on animals with the view of elucidating the various processes which occur in man.

No reliance can be placed on the efforts of nature in healing a wound in an artery in man, although it does occasionally occur. They are not to be even expected after a secondary hemorrhage, which is very rarely effectively suppressed without the assistance of art.

A *small puncture*, made with a needle, will sometimes heal, as it generally does in dogs. I have, however, seen several instances in which the femoral artery was wounded by a tenaculum during amputation, and a secondary hemorrhage followed after ulceration, requiring the application of a ligature. A *larger puncture*, or a longitudinal slit of from one to two lines in extent, does not commonly unite, except under pressure, although the edges of the wound may not always separate, so as to allow blood to issue in any quantity. It sometimes only oozes out, and occasionally does not do even that, unless some obstacle to the circulation takes place below, when blood is propelled with a jet; and the edges of the cut having once been separated, blood

continues to be thrown forth in considerable quantity. When the bleeding is suppressed by pressure made on the artery above, and all causes of obstruction are removed from below, the edges of the little wound approximate, and the circulation through the wounded artery may be, and often is carried on for several hours without further hemorrhage, when it may again recur without any obvious cause. In an artery of the size of the temporal a longitudinal slit may sometimes heal without the canal of the artery being obliterated, although this very rarely takes place in one of a large calibre.

In all cases of punctured wounds of small arteries, and particularly when the bleeding has ceased by artificial means, and pressure can be effectively made, and especially against a bone, it should be tried in a graduated manner over the part injured, in the course of the artery above and below the wound, and over the whole limb generally, the motions of which should be effectually prevented, and absolute rest of the whole body enjoined, if the artery is of any importance. This should be continued for two, three, or more weeks, according to the nature of the injury, and for some time after every appearance of recovery has taken place, in order to aid in the consolidation of the parts filling up the opening in the artery.

Case 1.—A medical student, being desirous of bleeding his friend in the arm, opened the ulnar artery which in this case was very superficial. On discovering the error he had committed, he closed the wound in the skin, and applied a firm compress and bandage, under which it healed, and the edges of the cut artery seemed to be in apposition, as little blood had escaped between them. On applying the ear to the part, it sounded like an aneurism, although there was scarcely any tumour, the thrilling sound being apparently occasioned by friction against the cut edges of the inside of the artery. This thrilling noise gradually diminished, and was lost as the artery became impervious. The vessel immediately below the wound gradually recovered its pulsation, except at the exact situation of the injury, where none could be distinguished. I have seen the same thing occur in wounds of both the arteries near the wrist, from punctures of a similar size, and I have reason to infer that it has taken place both in the axillary and the femoral arteries.

Case 2.—The master tailor of the 40th regiment, tempted by the approaching prospect of plunder, was induced, on the night of the assault on Badajos, to give up the shears, and arm himself with the halbert, and was properly rewarded for his temerity by a wound from a pike in the right arm, from which, he says, he bled like a pig, and became very faint. On his arrival at the spot indicated for surgical assistance he fainted, but this was attributed to the unwarlike propensities of the man, rather than to any sufficient cause. The wound was not more than one-third of an inch long, a little below the edge of the pectoralis major, and immediately over the artery. The arm and hand were numb and cold; the pulse was not distinguishable at the wrist, and it appeared to cease at the place of injury, which was harder and a little more swelled than natural. He said that his pulse had always been felt by the doctors in the usual place. I took him into my house to watch the case, and the wound healed without any trouble, attention being had to keeping the arm warm by covering. On the 1st of May the pulsation of the artery could be felt a little below the wound, and on the 6th it was distinguishable along the lower edge of the biceps. On any exertion he had a good deal of unpleasant numbness in the thumb and forefingers. A small cicatrix formed at the place of the wound, which was otherwise quite natural to the touch. The median nerve may have been injured; that the artery was wounded there can be no doubt, and that it healed without the least assistance from art, although it became impervious at the part injured. This case proves that when a large artery is wounded in man by a sharp cutting instrument, to a certain but moderate extent, the process of cure takes place through inflammation, and by the obliteration of that part of the canal of the vessel. Continental surgeons, and especially the French, have sacrificed whole hecatombs of animals to prove this fact, which had been so many years before recorded in England, as having occurred in man.

It has not been satisfactorily proved in man that a large artery, such as the femoral, has been opened to the extent of one-third or a fourth of its circumference, and that the wound has healed without the canal becoming impervious. Two such cases are stated to have occurred in the 23rd vol. of the *American Journal of Medical Sciences;* but as the pulsation distinguished in the lower part of the vessel was not perceptible in the first instance, and was only felt after a little time had elapsed, I am disposed to apprehend that dissection would show an obliteration of the canal in each, at the point injured, although it might not be for more than the eighth of an inch in extent. A *small wound* of a large artery may close without obstructing the canal of the vessel, but the part is not so firm or solid as before, and may yield, and give rise to an aneurism, having apparently the characters of a small true, as opposed to the spurious diffused or even circumscribed swelling, which more usually follows a similar accident.

Case 3.—Colonel F. was wounded by an arrow in the right side of the neck, opposite the bifurcation of the carotid, which caused a considerable loss of blood at the moment. The wound healed, leaving only a mark where the point of the arrow had entered. Some time afterwards he observed a small swelling at the part which, from its pulsation, was declared to be an aneurism. He therefore showed it to Sir A. Cooper, who advised his doing nothing, as it did not increase. Uneasy about it, he asked my opinion at Badajos after the siege. It had not increased, but it caused him some anxiety, and I promised to place a ligature on the common carotid as soon as the campaign was over

if it should increase in size. It did not do so, and nothing was done, as he was unfortunately killed in action the year afterwards.

In cases of this kind, and in that of Mr. Chamberlaine's, of Jamaica, in which he tied the axillary artery for an aneurism after a punctured wound to be noticed hereafter, the disease in the vessel seemed to be confined to the part wounded, and to be in reality a true aneurism, from the inner coats not having united firmly, and from the outer coat although united or healed having lost its elasticity, and become dilated—an effect which will, in all probability, follow an injury of an artery, when the obliteration of the canal does not take place. The wound in the artery may communicate with a vein.

Case 4.—Mr. Keate and Mr. C. Johnson have under their care in St. George's Hospital at present, a young man who received an injury from a knife, on the 28th of October, 1845, as nearly as possible in the inside of the middle of the right thigh, which bled profusely, until he fainted. The wound was then closed, and secured by compress and bandage for between two and three weeks, when on their removal it was found to be healed, but a small pulsating tumour had formed, for which he was sent to the hospital. This was manifestly an aneurism, but from the peculiar thrill it communicated to the touch, and which could be distinguished even above Poupart's ligament in the femoral and iliac veins, it is believed to be a *varicose aneurism*, which is said to be formed when the artery and vein have been both opened, having some cellular membrane as a means of communication between them, and through which the blood is propelled from the artery into the vein. When the blood is propelled directly into the vein so as to enlarge it, the complaint is called an *aneurismal varix*. The man being in bad health all operative methods were considered improper, and under a light but well regulated pressure on the part, the tumour is diminishing in size, is firmer to the touch, the thrill and sound are certainly less marked, and a cure may be effected, although in these cases it rarely occurs without a ligature being placed above and below the opening in the artery.

When an artery in man is cut *transversely*, or to a fourth of its circumference, it forms a circular opening as in animals, and if the artery be large the bleeding usually continues until the person faints, or it is arrested by pressure. The difference between arteries in man and in animals is here strongly exemplified. In dogs the bleeding commonly ceases without any assistance from art, and without the animal being exhausted; in horses and sheep they usually bleed until they die; whilst in man, even with the best aid from compression, hemorrhage will in all probability recur, unless the circulation be altogether stopped. If the external opening only should be closed, a spurious, circumscribed aneurism will be the consequence in so small an artery as the temporal, and I have often been obliged to lay open, and sometimes to apply a ligature above and below a little aneurism of this description. When it has been of a smaller size I have merely divided it transversely, and applied pressure; but there is some danger of the pressure becoming deranged, and of a return of the hemorrhage. In a larger artery the spurious aneurism may or may not be diffused.

When an artery is *completely divided*, it is less likely to continue to bleed than if it had been only wounded, and a variety of opinions have been entertained as to the means employed by nature, as well as by art, for the suppression of the hemorrhage.

In my work on the Diseases and Injuries of Arteries I have quoted the opinions of the most esteemed authorities—on the means employed by nature for the suppression of hemorrhage—from Celsus, Rufus, Galen, and Œtius down to Dr. Jones, the latest and most important of all. The methods they generally adopted appear to me to have been insufficient for and unequal to the object in view. They bled an animal until he died, and then reasoned on the manner or means by which the bleeding was suppressed, when it was in fact arrested by death. It is only when nature has not been interfered with, and the patient has not died from bleeding continued to the last moment, but has on the contrary lived some time after the hemorrhage has ceased, that the processes by which its suppression has been accomplished can be fairly investigated. These processes essentially depend on the size and variations of structure in an artery. They are dissimilar in large and small arteries, and not even quite alike in the upper and lower ends of the same artery—facts which were elicited from observations made on man on the field of battle during the Peninsular war, and consequently not liable to error.

Arteries of moderate dimensions, such as the femoral or axillary, tibial or brachial, and particularly all below these in size, are capable by their own intrinsic powers when completely divided, of arresting the passage of the blood through them without any assistance from art, or from the surrounding parts in which they are situated. This fact overthrows at once the whole theory which relates to the importance of and necessity for the sheath of the vessel, and the offices it performs in suppressing hemorrhage; and in a great measure, to that supposed to be derived from the formation of an external coagulum, the *bouchon* of the French.

Case 5.—A soldier who had his arm carried away by the bursting of a shell at the siege of Ciudad Rodrigo, was brought to me shortly afterwards. The axillary artery becoming brachial, was torn across, and hung down lower than the other divided parts, pulsating to its very extremity. Pressed and squeezed in every way between my fingers in order to make it bleed, it still resisted every attempt, although apparently by the narrowest possible barrier, which appeared to be at the end of the artery, and formed by its contraction. The orifice of the canal was marked by a small red point, to which a very slight and thin layer of coagulum adhered, the removal of which had no in-

fluence on the resistance offered by the very extremity of the artery to the passage of blood through it. In this, and in another instance of a similar nature, I cut off the end of the artery at less than an eighth of an inch from the extremity, when it bled with its usual vigour. In both, the vessel for near that distance was contracted so as to leave little or no canal at its orifice, which in these cases was filled by a coagulum of the size and shape of a very small pin.

Case 6.—During the battle of Salamanca a soldier was brought to me whose leg had been carried away by a cannon-shot. I found the posterior tibial artery pulsating to its extremity in a similar manner. As he had lost a considerable quantity of blood, and was much discouraged, I did not try to make it bleed, but amputated the leg forthwith, and examined the artery afterwards. I have had many opportunities of seeing the same thing, and therefore assert that it is in the very extremity of the cut artery that the power or means of suppressing hemorrhage resides after the vessel has been divided. In many cases of amputation, in which I wished the patient to lose a certain quantity of blood, I have allowed an artery to bleed until it ceased. The jet in such cases appears to be propelled at first irregularly, or by jerks, the stream then becomes continuous, although acquiring a little impulse from each contraction of the heart. As the orifice contracts, the flow of blood becomes more equal, it is thrown to a less distance, the size of the stream is smaller, and it goes on diminishing until at last the blood only oozes out, and by the time it ceases altogether to be discharged, the extremity of the vessel is covered by a thin layer of coagulum, which is readily removed from it. In many cases in which I have examined the parts after death or after amputation, in consequence of disease below the injury of the artery, this contraction of the vessel was evident, as well as the formation of the very thin layer of external coagulum, extending like a fine red thread into the canal of the artery. The sheath of the artery could, in the cases related, do nothing, because it was carried away—it was not present—neither did the internal coagulum, on which so much stress has been laid, because at this period, strictly speaking, it does not exist.

In small vessels, such as the radial or ulnar arteries, little depends on the diminished power of the circulation; but when the axillary or femoral artery is divided, the shock of the injury and the loss of blood, powerfully contribute in the first instance to the suppression of hemorrhage, by subduing if not momentarily arresting the action of the heart. Having thus established the fact by observation and experiment on man, that arteries in the extremities of the second order in regard to size, will cease to bleed through their own efforts, unaided by the assistance of the surrounding parts, I am far from intending to imply that no assistance is ever given by the surrounding parts when the femoral artery is cut across high up. When an artery of this size is divided in situ, and retraction has taken place, the wound in the limb being small and not direct, the assistance is oftentimes considerable, although it is only auxiliary by retaining the coagulated blood in its place against the ragged orifice of the contracting vessel. If the axillary artery be laid bare previously to an operation for amputation at the shoulder, and the surgeon take it between his finger and thumb, he will find that the slightest possible pressure will be sufficient to stop the current of blood through it. Retaining the same degree of pressure on the vessel, he may cut it across below his finger and thumb, and not one drop of blood will flow. If the artery is fairly divided by the last incision which separates the arm from the body, without any pressure being made upon it, it will propel its blood with a force which is more apparent than real. All that is required to suppress this usually alarming gush of blood, is to place the end of the forefinger directly against the orifice of the artery, and with the least possible degree of pressure consistent with keeping it steadily in one position, the hemorrhage will be suppressed. It is more important to know, that if the orifice of the artery from a natural curve in the vessel, or from other accidental causes, happens at the same time to retract and to turn its open orifice a little to one side, so as to place it in close contact with the side or end of a muscle, the very support of contact will sometimes be sufficiently auxiliary to prevent its bleeding.

In amputation of the hip-joint, the femoral, and profunda arteries are usually divided at, or just below the origin of the latter, and bleed furiously if disregarded; but the slightest compression between the finger and thumb stops both at once. They never have given me the smallest concern in these operations, or others of a similar nature, and I have learned to hold all arteries that can be taken between the finger and thumb in great contempt. It is quite impossible for a man to be a good surgeon—to do his patient justice in great and difficult operations attended by hemorrhage unless he has this feeling—unless his mind is fully satisfied of the truth of these observations. Whilst his attention ought to be directed to other important circumstances, it is perhaps absorbed by the dread of bleeding, by the idle fear that he will not be able to compress the artery and restrain the bleeding from it—that he may have half a dozen vessels bleeding at once—that his patient will die on the table before him. Once fairly in dismay, and the patient is really in danger; but, endowed with that confidence which is only to be acquired through precept supported by experience, he surveys this scene with perfect calmness; taking the great artery between the finger and thumb of one hand, he places the points of all the other fingers of both if necessary, on the next largest vessels; or he presses the flaps or sides of the wound together until his other hand can be set at liberty by an assistant, or in consequence of a ligature having been passed around the principal artery. I admit that this is a scene sufficient to try the presence of mind of any

man; but he is not a good surgeon who is not equal to it—who does not delight in the recollection of it when his patient is in safety, and his recovery assured. I have seen many persons die on the table under great operations. I never lost one from hemorrhage, except in one instance in which a tourniquet was applied. It was with no small satisfaction I heard a gentleman some six months ago, publicly state in the board-room of the Westminster Hospital, that the surgeons of another hospital to which he was especially attached, never used a tourniquet in amputation, and declare it to be an indication of their superiority over those who did resort to it for assistance. Joining most cordially in the approbation thus bestowed, I could not but feel gratified in recollecting that I was the first who publicly taught this method of proceeding; and it must be highly satisfactory to those governors who take an interest in the character of the Westminster Hospital to know that it was under their auspices and in their hospital it was first practised in London. It was in consequence of this recommendation that my old friend, Sir Charles Bell, whose loss to science cannot be too much regretted, represented me seated on a pack-saddle on the back of a bourro (*Anglice*, a jack-ass), on the top of the Pyrenees, expatiating on the merits of these barbarous proceedings to the descendants of the Bearnois of Henri Quatre with one hand, and to the children of the lieges of Ferdinand and Isabella with the other.

When the femoral artery is *cut across* in the upper part of the thigh, whether it be done by a cannon shot, a musket ball, or a knife, the patient does not always bleed to death at once, although he frequently dies after a time in consequence of the shock and the loss of blood. He is less likely to die if the artery is divided in the middle or lower half of the thigh, but in both cases it is probable the hemorrhage will cease of itself. If it should recur, it will be more likely to take place from the lower than the upper part of the artery, on account of the different process adapted by nature in these cases—facts, the knowledge of which we also owe to the war in the Peninsula.

Case 7.—At the battle of Toulouse, a large shot struck an officer and two men immediately behind him, and nearly tore off the right thigh of each. The artery was divided about, or less than three inches below Poupart's ligament. I saw him shortly afterwards in consequence of his surgeon saying it was a case for amputation of the hip-joint. The pulse was feeble, the countenance ghastly, bedewed with a cold sweat, and with every indication of approaching dissolution. The house being at an advanced point, and close to one of the French batteries, the fire of round shot and musketry was so severe upon and around it, as to induce me to remain until the battery should be taken by the troops then advancing upon our flank. In order to occupy my time usefully, I returned to the officer, and found he had just expired. Desirous of seeing by what means the hemorrhage had been arrested, I cut down upon the artery, took it carefully out, and found that its divided end was irregularly torn; a slight contraction had taken place just above, but not sufficient to have been of the slightest utility in suppressing the bleeding, which was in fact prevented by an external coagulum which filled up the ragged extremity of the vessel, and which in a few days would have been removed with the purulent discharge. The orifice of the artery, and the surrounding surface for at least an inch in extent would then be covered by a yellowish green-coloured matter, very distinct in appearance from the natural structure, and so strongly marked as to point out the situation of the extremity of the artery.

Case 8.—At Salamanca I had the opportunity of examining the thigh of a French soldier, whose femoral artery had been divided perhaps even higher up by a cannon shot. He lived until the next morning when I saw him, no operation whatever having been attempted, nor a tourniquet applied. He died exhausted, but not from any immediate bleeding, which when once stopped had not returned. The artery was in a similar state to the preceding one, with this slight difference, that the orifice was a little more contracted, the external coagulum filled up the ragged end of the artery, and was slightly compressed within by the contraction which kept it in its place. The rest of the coagulum filled the hollow in the surrounding parts which the retraction of the artery had occasiond. In this case, so unlike those I have hitherto noticed, the first natural cause giving rise to the suppression of the bleeding was the diminution of the power of the heart; the second the formation of a coagulum in the hollow of the sheath left by the retraction of the artery. Contraction had begun, but had done nothing essential.

If a case of this kind should survive, and the hemorrhage should be ultimately restrained by natural causes, I am led to surmise from what I have seen in the artery a little lower down, that the continued contraction which occurs in a circular direction just within the rugged or torn end would gradually lead to the protrusion of the external coagulum, projecting into its canal, like a mammillary process—an operation which would be assisted by the lymph or fibrin poured out from within and around the artery.

In other instances in which I have examined the extremities of such large arteries when divided, the appearances have been more or less of a similar nature; unless where the persons had died immediately, when the torn extremities were found quite open and with little surrounding coagulum.

The processes of nature are different in an artery of a somewhat smaller calibre. When the femoral artery has been fairly divided in the middle or lower part of the thigh, the patient has, in almost all the cases which have come under my observation, either died without assistance, or the hemorrhage has ceased spontaneously. Having been arrested for twelve hours, the efforts of nature are

usually sufficient to prevent its return from the upper, although not from the lower end of the vessel; but then it is of venous and not of arterial colour—a fact now acknowledged to be of the greatest importance. The great evil to be dreaded in such cases, is not from hemorrhage from the upper end of the divided artery, but from the lower, and from mortification of the foot, which circumstance I shall notice in its proper place.

The upper end of an artery retracts on being divided, and this retraction is accompanied by a contraction of the cut extremity of the vessel, which assumes the shape of the neck of a French wine-bottle or Florence oil-flask. The contraction is confined in the first instance to its very extremity, so that the barrier opposing the flow of blood is formed by this part alone. The contraction goes on, however, increasing for the space of an inch, which is usually filled up with an internal coagulum, of a round pyramidal shape, adhering firmly to the contracted end of the artery, loose at its apex, and extending frequently as far as the first collateral branch, but rarely under any circumstances beyond two inches; the very orifice of the artery on the outside being in a few days covered by the yellowish green-coloured matter I have already alluded to. Some of these processes are continued even after the external wound has healed; the artery goes on diminishing and contracting as far as it is useless, so that of four or five inches, from one to two may be impervious, the remainder being contracted although still permeable by a probe. An accompanying nerve where there is one would do the reverse, the cut extremity would be enlarged or bulbous, gradually diminishing as it is traced upwards, until it becomes of its proper size.

The processes adopted by nature for closing the end of the lower extremity of an artery of the size of the femoral at the inferior part of the thigh, are different from those employed at the upper or opposite extremity. The retraction or contraction of the lower end of a divided artery is neither so perfect nor so permanent as at its upper end, and the small internal coagulum is in many instances altogether wanting or very defective in its formation. The closure of the lower orifice being less perfectly accomplished than the upper, it is the most likely to suffer from secondary hemorrhage, which may be distinguished from that from the upper end of the artery at an early period after the accident, by the venous colour of the blood, and from its flowing or welling out in a continuous stream, as water rises from a spring, and not with an arterial impulse.

The retracting and contracting powers in the lower end of a divided artery are, nevertheless, considerable, and are sufficient in some cases to nearly close the lower end of the femoral artery when divided by amputation above the knee. When the femoral artery is cut across, the lower portion of the vessel is emptied by its last efforts, combined with the action of the capillaries. When the collateral circulation is powerful, blood soon regurgitates into the artery, but the force of the regurgitation can be in no proportion to that of the propulsion at the other or upper divided end of the vessel, which will generally be able to resist this impulse; whilst the lower one often opens and bleeds after the lapse of a few days. In all the cases I have had an opportunity of examining, in which hemorrhage had taken place from the lower end of the artery, the following appearances were observable after the interval of four to five days:—

The same kind of yellowish-green matter marks and conceals the situation of the lower extremity of the artery as it does the upper. It is however thinner where it immediately covers the end of the artery, which in none of these cases is contracted in the conical manner described as taking place in the upper extremity. On the introduction of a probe with the greatest gentleness into the artery from below, it usually makes its appearance at a point on the yellow space, raising a thin portion as it protrudes. On laying open the artery, the orifice would seem to have been once closed by this layer of fibrin, but with a less degree of contraction than the upper end of the same artery; the layer still however forming an obstacle sufficient to cover and close three-fourths of the orifice, the blood having flowed through the remaining fourth, which had probably given way by accident. The following case is illustrative of the several points alluded to.

Case 9.—Serjeant William Lillie, of the 62nd regiment, aged thirty-two, was wounded in the right thigh, on the 10th of April, at the battle of Toulouse, by a musket-ball, which passed through, in an oblique direction downwards and inwards, close to the bone, describing a track of seven inches. The ball was extracted behind on the field. He said he had bled a good deal on the receipt of the injury, which he had stopped by binding his sash around the limb. The discharge from the wound was considerable; it appeared, however, to be going on well until the 20th of the month, when, on making a sudden turn in bed, dark coloured blood flowed from both orifices of the wound in considerable quantity. I had given an order as chief of the medical staff in Toulouse, that no operation should be performed on a wounded artery without a report being sent to me, and an hour at least granted for a reply, unless the case were of too urgent a nature to admit of it. It appeared to be so in this instance, and before I arrived Mr. Dease had performed the operation for aneurism at the lower part of the upper third of the thigh. I could only express my regret that it had been done, and point out the probability of the recurrence of the hemorrhage from the lower end of the artery, which took place on the 7th of May, when the limb was amputated, and the man died. On examination the artery was found to have been divided exactly where it passes between the tendinous expansion of the triceps and the bone. The upper portion of the artery thus cut across was closed. A probe introduced into it from above would not come out at the face of the wound, although the impulse given to this part on moving

it was observable in the middle of a large yellowish-green spot, which I had previously declared to be the situation of the extremity of the artery, which had contracted behind this, in the shape of a claret-bottle for about an inch, having within it a small coagulum. The lower end of the artery from which the hemorrhage had taken place was marked by a spot of a similar character ; but on passing a probe upwards from the popliteal space, it came out at a very small hole in the extremity of the artery, in the centre of the yellow spot, the canal of the artery not being contracted and diminished, but only apparently closed by a layer of the yellowish-green matter laid over it, and adhering to its circumference.

Case 10.—A soldier of the German heavy cavalry was wounded nearly in a similar manner at the battle of Salamanca, and died in the night, some days after the injury, from inattention. The appearances were nearly the same, and I have had so many opportunities of verifying these points, that I do not hesitate in considering the following as three important facts, first demonstrated and proved during the war in Portugal, Spain, and France, and that nothing has since occurred to impeach their accuracy.

1. That an artery as large as the femoral is capable, when divided, of taking on certain processes, which will cause a suppression of hemorrhage from its upper end, and which suppression is usually permanent.

2. That the bleeding from the lower end of the same vessel is less certainly and less permanently restrained, and not by exactly similar processes; the blood issuing from the lower end of the femoral artery being for the first few days of a venous colour. It is less so from the axillary artery, in consequence of the collateral circulation in the upper being more free than in the lower extremity, and the change of colour is sometimes not perceptible in the smaller arteries of the forearm, although it is generally so in those of the leg.

3. That this bleeding from the lower end of the vessel, which is more or less of a venous colour, and issues in a continuous stream, may be restrained by compression properly made on, and in the course of the lower part of the wounded artery ; but that in no instance should recourse be had to a ligature on a distant part of the artery above the seat of injury, until every other possible effort to arrest the hemorrhage has failed.

LECTURE II.

Partial division of arteries; Case of partial section of the brachial artery; Case of slit in the femoral artery; Wound of a deep-seated artery the cause of extravasation of blood in the cellular structure of the limb, forming a non-pulsating tumour in general; Pulsations of some tumours caused by the impulse given to them as a mass by the artery against which they are lying; The whizzing sound or thrill absent in such cases; The extravasated blood, if it remain fluid, causes suppuration, if coagulated, is absorbed; If it increase in quantity, the wounded artery should be cut down upon, and tied. The external wound in these cases the guide for the incisions in cutting down upon the artery; Distinction between a false aneurism from a wound and from disease; Operation for a false aneurism from a wound; Mr. Keate's case; M. Delpech's case; Professor Petrunti's case; The false aneurism should be laid open as soon as its nature is ascertained; Injury of an artery by external violence; Case of aneurism in the lower part of the thigh from a blow; Inflammation and abscess following an injury to an artery; Diffused aneurism from the same cause; Enlargement of the collateral circulation after ligature of an artery. Two distinct kinds of collateral circulation; Mortification of a limb the result of a sudden injury to an artery, the collateral branches not having time to enlarge; The external iliac ought not to be tied for diffused aneurism in the groin from punctured wound of the femoral artery; Will cause mortification of the limb, or peritoneal inflammation, with the formation of matter behind it, on secondary hemorrhage from the unclosed ends of the artery, or suppuration of the sac; Ligature of the subclavian inapplicable for a wound of the axillary artery; The Hunterian theory of the cure of aneurism totally and utterly inapplicable to the treatment of wounded arteries accompanied by an open wound; A wounded artery should be secured at the part where it is injured; Case of aneurism in the ham, with an increased number of the collateral branches; Case of wound of the femoral artery by a musket ball; Occurrence of mortification, requiring amputation; Condition of the wounded artery; Case of musket-shot wound of the femoral artery; Fatal mortification; Case of musket-shot wound of the femoral artery and vein; Secondary hemorrhage; Ligature of the wounded vessels; Fatal mortification; Wound of the popliteal artery; Mortification, amputation, death; Wound of femoral artery; Occurrence of mortification ending fatally, from the non-performance of amputation; Wound of the femoral artery; Partial mortification; Occurrence of secondary hemorrhage; Ligature of a large branch of the femoral by mistake; Death; Wound of a branch from the profunda; Improper ligature of the femoral, terminating fatally. Cases of mortification from injury of the popliteal ending fatally while waiting for the line of demarcation; Fatal mortification from arteritis; Case of diffused aneurism from injury of the popliteal, threatening gangrene; Treatment by incisions; Case of ligature of the common iliac for supposed gluteal aneurism; Prevention of mortification by frictions on the limb for twenty-four hours; Conclusions.

When an artery is merely cut or torn half through, but not completely divided in the first instance, it is in the same state with regard to hemorrhage, as if it had partially given way by ulceration. It can neither retract nor contract, and will continue to bleed until it destroys the patient unless pressure be accurately applied, and maintained until further assistance can be procured. The practice to be pursued is to divide the vessel if it be a small one, such as the temporal artery, when it will be enabled to retract and contract; and the bleeding will in general permanently cease under pressure, especially when it can be applied against the bone. If the artery is of a larger class, and continues to bleed, it should be sufficiently exposed by enlarging the wound; a ligature should be applied above and below the opening in the vessel, which may or may not be divided between them at the pleasure of the surgeon.

Case 11.—During the battle of Talavera, in 1809, a man was brought to me who had lost a large quantity of blood from a wound made by a musket ball in the arm, which had bled profusely, and was only arrested by tying a handkerchief tight over the wound. The brachial artery, just below the edge of the pectoral muscle, had been half cut across, and on being exposed again, bled furiously. A ligature was placed on the artery, above and below the wound, and the man perfectly recovered.

Case 12.—In June, 1829, I happened to be at Windsor, on a visit to my old friend the late Dr. Fergusson, and was called to a young gentleman, the upper part of whose right femoral artery had been accidentally cut by the point of a scythe. On dilating the wound, a tourniquet being on the limb, black blood flowed freely from it; on unscrewing the tourniquet by degrees, arterial blood showed

itself, and the upper end of the artery was secured by ligature when the tourniquet was removed. Venous-looking or black blood then again flowed in greater abundance than before, and evidently from a large vessel. This I restrained by pressure made below the wound with the thumb of the left hand, whilst I laid bare the lower part of the artery, from a slit in which near an inch in length, the black blood was seen to flow. A ligature passed around the vessel below the wound, suppressed the bleeding. The artery was not divided, and the young gentleman perfectly recovered, and has continued well until this day. The absolute necessity for two ligatures was here well shown, as well as the flow of dark coloured blood from the lower end of the artery.

When an artery is wounded at some depth from the surface, and the external opening is small, blood not only issues through the opening, but is often forced into the cellular structure of the limb to a considerable distance, the pulsation of the tumour is observable, and the thrill or sound which accompanies a ruptured artery is distinct. If a large quantity partly in a fluid, partly in a coagulated state, is collected immediately over and around the wound in the artery, the tumour may not pulsate or give forth any sound if the coagulated blood is in considerable quantity, although some elevation of the tumour may be observed corresponding to the pulse.

This rising or pulsation of the swelling often depends on the impulse given to the whole as a mass by the artery against which it is lying, and not upon blood circulating through it. An impulse of this kind is distinguishable in a bronchocele, which lies immediately over and in contact with the carotid artery, and was well shown in two cases which came to me from the country for operation, being supposed to be aneurisms. The mere act of deglutition removed the tumors from the artery, and showed they belonged to the trachea, and not to the vessel, and when elevated, the pulsation was nearly indistinct. It is the same when blood is extravasated by the rupture of small vessels, in consequence of the passage of a wheel over the limb, and especially in the thigh, where I have seen a swelling containing fluid blood pulsate in an almost alarming manner, until it gradually diminished as the blood coagulated, when the motion became a mere elevation at each stroke of the heart. The whizzing sound or thrill attendant on a ruptured artery is in these cases wanting, being a very diagnostic mark of this accident, although I am well aware that where there is true aneurism, and it has burst, forming a diffused and spurious one, the thrill may be wanting, but the history of these cases enables a surgeon to distinguish between them. If several ounces of blood are thrown out, and remain fluid, they ought to be evacuated, or suppuration will ensue. If they become coagulated, the mass will be gradually absorbed. Fluid blood should be evacuated by a small opening, and the part afterwards treated by compress and bandage. If the fluid or partly coagulated blood should increase in quantity, and the swelling continue to enlarge and pulsate, the extension of the mischief should be arrested by opening the swelling and securing the artery by ligature.

When the external opening is enlarged, and the clots which filled it up are at all disturbed, arterial blood begins to flow, and the finger will readily follow the track through which it passes down to the artery, if it should not be too far distant. If the incision is made sufficiently large to enable the operator to remove these clots of blood with rapidity, the finger will more readily pass down to the wound in the artery, which, if a large one, may be thus easily discovered, if within reach and sight, provided the tourniquet be thoroughly unscrewed, and the surgeon is not afraid. A ligature should then be placed above and below the opening in the artery. M. J. Z. Amussat, in a memoir read before the Royal Academy of Sciences, of Paris, in February, 1843, has dwelt at length on, and has attached perhaps more importance to this track leading from the external opening to the wound in the artery, than it appears to deserve. The great merit of his work is, however, the acknowledgment which he thinks it a matter of great importance to make, and which he supposes he has deduced from his own observations, "that the surgeon should take the wound for his guide in all these cases of aneurismal swelling, and follow the conducting canal in the tumour itself down to the wound in the artery, which is to be secured by ligature above and below the opening in it, unless the external wound should be too distant from the course of the vessel." This is a fact worthy of remark, being an acknowledgment of the correctness of those opinions, and of that practice I have promulgated by my writings and lectures since the battle of Albuhera, in 1811.

When an artery is wounded, and the external opening in the integuments heals so as to prevent the blood from issuing through it, a traumatic, spurious, circumscribed, or diffused aneurism is said to form, according to the facility which is offered by the structure of the parts for the confinement or diffusion of the extravasated blood. A traumatic aneurismal tumour of this nature differs essentially from aneurism which has taken place as a consequence of disease, and not of direct injury. If a spurious aneurism forms from disease, the artery is in general unsound for some distance above and below the tumour. In the aneurismal tumour from a wound, the artery is perfectly sound, except as far as concerns the seat of injury. There is then not only a great and essential difference between these two kinds of aneurism as regards their nature, but also with respect to the collateral circulation, and the operation to be performed for their cure; and the surgeon may not overlook these facts.

Case 13.—A school-boy, about fourteen years of age, let a penknife drop from his hand while sitting down, and drew his knees suddenly towards each

other to catch the falling knife; the point was thus forced into the inner and middle part of the thigh, and wounded the femoral artery. The medical man on the spot put a plaster on the little incision in the integuments, and the wound quickly healed. The boy complained of uneasiness, but was supposed to be making more of it than necessary, and was made to go into school as usual. The limb however began to swell, and the boy was brought to London, and consulted his family surgeon, who put him to bed, and poulticed and fomented him, expecting an abscess had formed, which I was sent for to open during his illness. I found the limb very much enlarged from the upper part to the knee, and with that peculiar discoloration which convinced me that blood was under the integuments, and I refused to open it where the abscess was supposed to be pointing, until I had everything ready for the operation of securing an artery. There was no pulsation to be felt when I first saw it, and I was assured there had been none. When all was ready I introduced the point of a lancet, and after a clot of blood had been forced out, a jet of arterial blood flew across the room. The hemorrhage was arrested by pressure below Poupart's ligament, whilst I enlarged the opening in the integuments. Two washhand-basins were filled with coagula, and I put my finger on a large opening in the artery, under which two ligatures were passed by means of an eye-probe, and the artery was divided between them. The muscles had been cleanly *dissected*, and the cavity extended from the fork internally, and trochanter externally, to the knee. There was much less suppuration than I expected. The ligatures were detached about the usual time, and the patient entirely recovered. This case was given to me by Mr. Keate, and the following is from *Delpech Clin. Chir.*

Case 14.—M. Maigret was wounded by a small triangular sword in October, 1816, in the lower part of the left thigh; the anterior wound bled profusely, but the bleeding was arrested by compression, and at the end of eight days both the external wounds had healed. On moving about incautiously he felt pain in the part, and perceived a small tumour under the cicatrix in front, about the size of a nut, and which rapidly increased, so that on the fifteenth day the femoral artery in this case, accompanied by *two* veins, was tied above the edge of the sartorius muscle, by an incision begun three inches below Poupart's ligament. The patient perfectly recovered, although it was a long time before the swelling totally disappeared.

Case 15.—Raffaele Castaldi, aged thirty-seven, was stabbed, July, 1824, on the external and superior part of the left thigh, and lost a considerable quantity of blood. The wound closed, and at the end of eight days a small, but strongly beating tumour was observed opposite to the cicatrix. The treatment of Valsalva was adopted, and ice and astringents were applied to the swelling. These means were continued until December, and ultimately led to the formation of a deep eschar on the face of the tumour. On the cicatrisation of the ulcer left by this, the swelling was found to be diminished, to be hard, and without pulsation. At the end of a year, believing himself cured, he placed a piece of copper over the firm swelling, by way of protection, and returned to his usual laborious exercises. In November, 1834, twelve years afterwards, on lifting a heavy weight, he felt something give way in the old swelling, which immediately became larger, and beating, and in 20 days extended from one inch below Poupart's ligament to the lower fourth of the thigh. Professor Petrunti applied a ligature immediately below Poupart's ligament, which came away on the thirteenth day. On the thirtieth, the wound was nearly healed. On the thirty-first day, bleeding took place from the wound, which was restrained by compression, but returned on several occasions. A compress and tourniquet were then fitted on above Poupart's ligament, which succeeded in stopping the hemorrhage, but gave rise to a deep gangrenous eschar, which took a long time to cure. Three months after the operation the wound healed, the tumour gradually diminished, and the patient ultimately recovered.—*Gazette Medicale*, 1835, p. 647.

Case 16.—A young man of sixteen was wounded on the inner and lower part of the thigh by a penknife, and lost a considerable quantity of blood, which was restrained by compress and bandage, and the young man was kept in bed for three weeks, when a profuse bleeding took place, which was again suppressed by his bandages. He suffered severe pain during the night, and the next day the formation of a swelling at the wounded part was evident. Three more bleedings took place, the swelling increased so as to occupy two-thirds of the inner aspect of the thigh; and exactly one month after the accident it was decided in consultation that the artery should be secured. Mr. Bell made an incision between five and six inches long, taking the *original* wound as a centre, removed all the fluid and coagulated blood, placed a ligature above and then below the wound in the artery, and closed the wound. The young man perfectly recovered, the limb two years afterwards being in no way deteriorated by the injury. This case is from the *Lancet*, vol. 1830—31.

These four cases show three different modes of treatment. Mr. Keate, called upon to open an abscess, demurred, doubtful whether he had not a diffused aneurism to deal with. M. Delpech knew he had a diffused aneurism before him, but which was not so large as to preclude his placing a ligature above it, yet below the profunda, on which, he says, he reckoned for the support of the limb. He succeeded, and his operation (of Anel) was admissible, because there was no external opening communicating with the sac, and that the blood in it was coagulated. If it had remained partly fluid, partly in clots, suppuration would in all probability have taken place, and a renewal of the bleeding might have occurred, requiring another operation. The proceeding adopted by Mr. Keate and Mr. Bell was therefore the safest and the best, even under the most

favourable circumstances. In M. Petrunti's case the tumour was not absorbed, and the artery yielded after an interval of twelve years from the receipt of the injury, probably from becoming diseased. The operation of Anel failed, when that of Hunter on the external iliac would have been done by all English surgeons, and would have succeeded, inasmuch as there is reason to believe that the upper part of the femoral artery was unsound, whilst the compression above the pubis, which gave rise to the deep gangrenous eschar, obliterated the canal of the external iliac artery in a similar manner to the operation.

The great error in all these cases consisted in not laying open the tumour on the eighth or tenth day, whilst it was small, or as soon as its nature was distinctly ascertained, and placing a ligature on the artery above and below the wound. If a tumour of this kind, being circumscribed in the first instance should burst, and blood be in consequence poured out into the cellular membrane of the whole limb, it swells enormously, and gangrene is oftentimes only prevented by amputation. This may occur in a case of true aneurism, and is always a very dangerous accident. If taken in time the ordinary operation for aneurism may suffice, if long-deferred, amputation will be a last but not often a successful resource.

An artery may be injured by external violence without being punctured, and without any external wound, the consequence being the obliteration of the canal, mortification of the extremity, or the formation of an aneurism, which may be a true one by dilatation if the internal coats only are affected, or it may, through ulceration, suppuration, and sloughing, be spurious, and circumscribed, or diffused.

Case 17.—A stout, young, and healthy man was admitted into the Westminster Hospital with an aneurism of the lower part of the thigh, about the size of a small but flattened orange. Some three months before, he had received a sharp blow on this part from the edge of a piece of hard leather, which gave him acute pain for a time, and he some days afterwards discovered the beating swelling for which he was sent to me. A ligature, composed of one thread of strong dentist's silk, placed on the femoral artery in the lower part of the upper third of the thigh, came away on the twelfth day, and the man perfectly recovered. There can be little or no doubt of the aneurism having formed after a partial rupture or derangement of the inner coats, and from a dilatation of the outer coat of the artery.

Case 18.—A young and healthy man, of a vigorous constitution, was discharged from a cavalry regiment, and sent to me with an aneurism of the thigh, where the artery passes through the triceps. Some weeks previously the horse of another soldier had run against him when on horseback, and forced the end of a hard holster between the affected thigh and the saddle, giving him acute pain at the part, which subsided into an uneasiness for a day or two, some time after which he discovered a small beating swelling, which gradually enlarged, and prevented his riding, and on account of which he was discharged. I admitted him into the Westminster Hospital, placed a ligature on the femoral artery at the usual place, and he perfectly recovered.

When inflammation and abscess follow an injury inflicted on the artery through violence, without an external opening, or if sloughing should take place, the treatment by incision is absolutely necessary, as well as the application of two ligatures to the artery. When a diffused aneurism forms rapidly in a limb after a great injury, but without an external wound, the place in which the artery or arteries is or are injured being unknown, the case is greatly complicated, and requires the most serious consideration, whether the trunk of the artery shall be tied or the limb be amputated. If signs of mortification occur, the limb should be cut off forthwith.

A correct knowledge of the collateral circulation is of the utmost importance; surgeons understand by it the means whereby blood is sent to the extreme parts of a body, or to a limb, when the usual supply through the principal trunk is cut off. This collateral circulation is more perfect, more active in young persons during the increase or growth of the body, than it is either at maturity, or in the decline of life. The important point is not, however, alone referrible to the time of life in which the continuity and permeability of the main trunk ceases to exist, but to the nature of the disease or injury which has given rise to it.

When an operation has been successfully performed for aneurism, and the patient has died, some time afterwards dissection has shown various arteries enlarged, both above and below the part where the trunk was obliterated by the ligature; and not only an enlargement of arteries, which from their regularity have received names, but others have been developed not usually known to exist, or not of a size to be conveniently traced. These through their frequent anastomoses bring the blood at last into several larger trunks, by which it is again conveyed to the original vessel below all and every obstruction which may have taken place; thus compensating by a circuitous route for the loss of the direct supply. The principal object of inquiry is, do these vessels always exist, or at what period of time do they begin to enlarge, so as to enable them to carry on the circulation, in the manner in which it is presumed to be done?—for few will assert, that the enlargement of these particular collateral vessels was an accidental play of nature, and existed previously to the commencement of the disease or injury for which the operation was performed. On this point, the theory of the operation for aneurism and its applicability to wounded arteries appears to hinge; and what is of more importance, on which the practice resulting from it depends.

Two distinct kinds of collateral circulation are at present acknowledged: one by direct large communicating arteries; the other through the indirect medium of the capillary vessels, inosculating with each other. Where the direct communicating arteries exist, little subsequent change takes place in them.

It is otherwise with the indirect capillary vessels. When the radial or ulnar artery is divided in the hand, the blood will not only flow readily from each end of the divided vessel, but equally red and arterial from both; the communication being through direct arterial branches from one vessel to the other. It will also be red and arterial if the division take place at the wrist; and may be so in the brachial, but if the femoral in the lower part of the thigh be wounded, the colour of the blood issuing from the lower end of the artery, if any issue at all, will be venous. It is so, because it has been obtained from the capillary arteries, which in this case being empty receive blood by regurgitation from the veins, the valves of which when present do not prevent its reflex course. If a limb be injected and carefully dissected four or five days after a ligature has been placed during life high up on the principal trunk, the capillary vessels will be seen to be well injected; but few or none will be found large enough to admit of their inosculation being traced throughout. If another limb be injected and dissected, some sixty days after the ligature has been applied,—and opportunities have occurred of making such dissections in man,—a difference will be distinctly observed between the two preparations. In the latter, the capillaries will not appear to be so fully injected, but several larger and more tortuous vessels will be found in situations where they were not expected to exist; and the anastomoses of these one with another, and generally by arches, may be traced to their communication with the principal trunk, both above and below the obliterated parts. If an incision were made in the nearest pervious portion of the lower part of an artery of a person who had undergone this operation, arterial blood would issue from it. The communication would have become direct by communicating branches, and the capillaries would have returned to their accustomed duties.

During the first twenty-four hours after the division of an artery such as the femoral, or the application of a ligature, the temperature of the limb is commonly diminished; after that period, and as the action of increase takes place, the temperature is usually from three to five degrees higher than in the opposite healthy limb. At the end of from eighteen to twenty-eight days, in a successful case, the temperature is found to be equal in both.

It is asserted by some sanguine supporters of the all-powerful influence of the collateral circulation, that it is sufficient at all times, and under all natural circumstances, to maintain the life of the extremity. The practice of the Peninsular war proved the fallacy of this opinion in too many instances, to admit of any doubt of its inadequacy to do so in the lower extremity after the division of the femoral artery, under ordinary circumstances. The fact of enlargement or of a new development of vessels having taken place after the commencement of the disease, or the reception of the injury has been demonstrated by dissection, and it is through them the life of the limb is to be preserved.

It is most reasonable to conclude, that the collateral branches begin to enlarge shortly after the commencement of the disease, as a part of the curative process which nature endeavours to set up in most instances; the essential points of which are, in an extremity, 1st, the obliteration of the canal of the artery immediately above, and generally below the tumour; 2nd, the coagulation of the blood within it; 3rd, the enlargement of the collateral branches above and below it.

When a limb is lost through mortification, as the consequence of a division or obstruction of the principal artery, it usually takes place after the infliction of a sudden injury, in consequence of the collateral branches not having had time to enlarge.

In my work on injuries of arteries, and in this place, treating of the collateral circulation, I have asked the question:—"If the femoral artery be punctured near the groin, and a diffused aneurism form in a few days, extending up to Poupart's ligament; can the operation of placing a ligature on the external iliac be performed on the same principle, or with the same hope of success, as if the case had been one of true aneurism of several weeks' or months' formation? The answer is in the negative. The Hunterian theory of aneurism is not applicable to the case. The surgeon who placed a ligature on the external iliac, under such circumstances, would probably lose his patient from mortification, because the collateral branches would not yet have had time to enlarge." I may now add, if he should escape this danger, there is the risk of inflammation of the peritoneum which has occurred to myself and to several others, and of the formation of matter behind it; or the wounds if not closed may bleed, or the diffused and spurious aneurism may enlarge from blood flowing into it from both ends of the artery, which are not partially closed, as in true aneurism; or it may suppurate, and burst, and require in each case another operation, in order to suppress the bleeding. It is an operation which I shall show you cannot be supported on principle, which has not succeeded in practice, and which will be resorted to hereafter only as a last resource, when those means I have pointed out, have unfortunately failed; and when in all probability it will fail also.

The operation for placing a ligature on the subclavian artery, above the clavicle, in a case of wound of the axillary artery in the armpit, is equally inadmissible with that for applying a ligature to the external iliac for a wound of the artery in the groin, and ought alike to be abandoned. These are grave questions which interest the public more than the profession. They only indirectly affect the anatomist and the surgeon, who does one operation with the same degree of knowledge and ability as the other. To the public, to the sufferer, they are questions of life or death. By that operation, which during the war in the Peninsula was found to be efficient, the sufferer has a fair hope of recovery; after the Hunterian operation, he may live through accidental circumstances only, which

may be prayed for, but which can never be honestly and fairly expected. They should never therefore be trusted to, for nothing which is dependent on chance or accident can or ought to become a principle in surgery. The Hunterian theory of the cure of aneurism is totally and utterly inapplicable to the treatment of wounded arteries, accompanied by an open wound, however small or distant. It is always doubtful, and frequently dangerous and destructive even where the external wound has healed. A wounded artery should always be secured at the part where it is injured, and the greater number of those who suffer from such accidents, and are not so treated, will in all probability be lost, unless surgery can come to their assistance by ulterior and more painful operations.

When an aneurismal limb has been injected, on which an operation has not been performed, the collateral vessels have all been found larger and more fully shown than on the opposite side, although not to the same extent as in cases of a similar nature in which the operation has been done.

It is necessary that this enlargement of the collateral branches should take place at an early period, because in many cases of aneurism the artery beyond or below the tumour is obliterated long before any operation is performed. The main supply of blood has been already cut off from the extremity, and the operation adds very little to the derangement of the circulation which has for some time taken place below the tumour. The following case shows the increase of collateral vessels so as to double the number on the opposite side.

Case 19.—Alexander M'Donald, 28th regiment, was admitted into Hilsea Depôt Hospital, for a gangrenous spot on the great toe of the right foot, which soon got well. Twelve days after his admission, a pulsating tumour was first observed in the ham of the same side. On the 7th of August the tumour was of the size of an egg, and the arterial action strong in every part of the body. He died suddenly, and on examination the right femoral artery, or of the diseased side, was larger than that of the left. The aneurism was situated exactly at the spot where the popliteal artery divides into the posterior and anterior tibial arteries, and was of the size of a walnut. The posterior tibial opened directly into the sac. The orifice of the anterior tibial artery, which had originally opened into the sac, was closed, as well as about three-eighths of an inch of the vessel. Within the space of six inches above the aneurismal sac, the artery gave off fourteen branches in pairs, larger than those in the opposite limb, which were only seven in number.

These facts appear to me to be conclusive: they show that the collateral circulation is not the same, and is not in the same stage of preparation, in a limb suffering from a divided or wounded artery, as in one in which an aneurism has for some time existed; and they also show why mortification is more common after wounded arteries than after operations for aneurism.

Case 20.—Private J. Barnes, 29th Regiment, on the 16th of May, 1811, at the battle of Albuhera, received a musket ball in the right thigh, behind and above the knee, inclining downwards and inwards, close to the condyles of the femur, and in the direction of the femoral artery becoming popliteal; it bled violently at the moment, and so continued for a few minutes, during which time he conceives he lost two quarts of blood. It then ceased, and he was dressed in the usual slight manner, and remained two days upon the field of battle, until removed to Valverde, nine miles, on a bad road, and on men's shoulders, in a blanket converted into a bearer. He was considered as one of the slighter cases, until the gentleman in immediate charge of him requested me to see him, on account of his toes being in a state of mortification.

On the evening of the 3rd of June, eighteen days after the accident, the man was placed on a bullock car, to be removed with the rest of the wounded to Elvas; the mortification of the foot having ceased to increase, and a line of separation having been formed. Shortly after the cars moved, I was informed that he was bleeding from the wound: it evidently appeared to flow from the popliteal artery; and as it issued slowly, I supposed from the lower divided end. The foot being partly lost, I determined on amputation above the knee, which was performed at Olivença. The amputated limb was sent after me to Elvas, that it might be examined at leisure. I carefully traced the course of the wound, and found in it a little coagulated blood, but could not see the mouth of the vessel. A probe passed into the upper end of the artery was obstructed before it reached the ulcerated surface by nearly an inch; and on passing it up the lower one, it was stopped exactly in the middle of the track of the ball, by a veil or substance drawn across the mouth of the vessel, which, on careful examination, showed the point of the probe at one part of the circle, although too small to let it through; from this part I conceive the hemorrhage came. The divided ends were one inch apart. The upper, or femoral portion, for near an inch, contained a firm coagulum, filling up that part of the artery which had contracted like the neck of a claret bottle. The lower or popliteal portion of the artery had a very peculiar appearance; the substance drawn across appeared to have closed it completely at one time, and to have given way from the rough motion of the car at the point now open, and which is very small even when the sides of the artery are approximated. A very little soft coagulum was behind it; and if the man had not been removed, the vessel might have remained secure. This case shows very distinctly the means adopted by nature for the suppression of hemorrhage from both ends of a divided artery. The preparations I shall place in the Museum of the College of Surgeons.

Case 21.—In another soldier, under similar

circumstances as to the nature of the wound and mortification of the foot, no hemorrhage took place on the journey to Elvas, but the man died three days after from mortification of the leg. He did not remain under my direction at Elvas, and no examination of the limb was made.

Case 22.—Serjeant Baptiste Pontheit, of the French 64th regiment, was wounded by a musket ball at the battle of Albuhera, on the upper and fore part of the thigh, which passed out behind, in the direction of the femoral artery. He lost a great quantity of blood at the time, to the best of his recollection, and the wound went on well until the 26th, ten days after the battle, when he felt something give way in his thigh, and found himself bleeding from the wound, which however soon ceased on pressing his hand upon it. In the afternoon on again moving, he lost about half a pint of florid blood, which induced the surgeon on duty to place a touruiquet on the limb, and inform me of the circumstance. When at leisure (in the course of two hours) I removed the tourniquet, and as no hemorrhage occurred, and there was no swelling in the vicinity of the wound, I replaced the dressing with a precautionary screw tourniquet, explaining to him its use, and the probable nature of his wound, together with the operation requisite to be performed in case of further bleeding.

I should before have mentioned that he was not a strong man, and was exceedingly anxious about his situation, and very restless: on turning at night he lost a little more blood, which ceased by his tightening the tourniquet, which was shortly after loosened. In the morning, every thing being removed, there appeared some swelling about the wound, the opening of which was filled up by a coagulum: gentle pressure being made, it readily turned out, and was followed by a stream of arterial blood, leaving little doubt of the femoral artery being wounded. Compression being made in the groin, I made an incision three inches and a half in length, taking the wound as a central point, and exposed the femoral artery and vein: both were wounded, the former being half destroyed in its circumference, surrounded with coagulated blood, and appearing as if it had sloughed from being touched by the ball, the course of which was directly past it, and I conceive would have carried it away, if it had not been for the elasticity of the artery. A ligature placed above, and another below the wound, secured both artery and vein; the incised wound was brought together by adhesive plaster, and the limb placed in a relaxed position. The operation was of short duration; he lost little or no blood, but the circulation was very languid, and the man exceedingly low. The warmth of the leg and foot was soon below the standard of the other; warm flannels were applied, and some brandy and water was given to him. In the evening the heat was more natural, and the man returned thanks for the humanity and kindness shown to him, congratulating himself and me upon the success of an operation which he had supposed to be infinitely more severe. The next morning he ate a tolerable breakfast, but felt a pricking sensation in the calf of the leg, which was as warm to the hand as the other, but the foot was cold. The second day, the swelling of the limb, its appearance, and discoloration on the under part, indicated approaching mortification, which on the 3rd was evident, and on the 4th at mid day he died, the limb up to the wound being nearly all in a gangrenous state. No adhesion had taken place in the wound, or in the artery, which showed the inner coat cut, the ligatures being firm, and no coagulum behind them. In this case, nature appeared from the first quite unequal to carry on any of the necessary operations; which may have arisen from the very debilitated state of the patient, as well as from the double obstruction to the circulation. He was a very gallant soldier, had been in twenty battles, was to me an object of solicitude, and had every attention it was in my power to bestow. He begged me to keep his watch, and although it is worth nothing, I do keep it as a relic of by-gone days.

Case 23.—Captain St. Pol, of the 7th or Royal Fusiliers, a son of his Majesty Louis Philippe, King of the French, by an English lady, was wounded in the ham from behind, whilst in the ditch at the foot of the great breach at Badajos. He fell instantly, and lost as he thinks, a considerable quantity of blood. On recovering he was raised from the ground, and walked a few paces prior to his being carried to his tent, where I saw him in the afternoon of the next day, the 7th. The leg had ceased to bleed before his arrival in camp. A substance could be felt on the inner side of the patella, which by the sensation communicated to the finger on moving, appeared to be the ball, which was extracted. A small artery was accidentally divided, and some dark-coloured blood also issued from the cavity; the ball was lying loose and unconnected; the finger on being passed into the joint which was swollen, discovered no splinters of bone, and the entrance of the ball behind would not admit the finger. His having walked some distance on the leg, and the absence of any splinters between the articulating extremities of the bones, induced Dr. Armstrong, the surgeon of his regiment, and myself to think that the ball had entered with little injury to the bone; and after stating to the patient the little hope we had of ultimately saving the limb, independently of the great danger to which he was exposed, compared to the certainty of the operation of amputation at the moment, to which he would not consent, we assented to his retaining the limb for the present, thinking he would at least get through the inflammatory stage, when the operation could be performed satisfactorily to himself, although under much more unfavorable circumstances. The next day he was removed into Badajos on a litter, the heat of the tent being insupportable.

On the morning of the 9th I saw him early, being a friend in whom I took the greatest interest, when the want of circulation in the foot was evident from its having lost its natural colour and warmth; the knee was swelled, but not painful, and I had no

doubt that the artery had been divided by the ball. The marbled appearance and tallow-white colour soon indicated the loss of the leg above the calf; and vesications formed on the foot, already of a green colour.

On the 12th the extent of the gangrene was defined, on the back of the knee up to the original wound at its lower edge, gradually receding as it advanced to the fore-part of the leg, which for three inches below the knee was apparently sound; the uneasiness of the knee being moderate, and the incised wound looking perfectly healthy, although the latter had not united.

On the 16th the separation of the dead from the living parts having taken place behind, and being well marked and commencing on the fore part, the limb was amputated as low down as possible. Sixteen vessels were tied; the parts were gently brought together, without any hope of union.

On the 18th, there being some swelling of the stump, the strips of plaster were removed, one only remaining as a support to the vessels.

20th. Half the ligatures came away at once, they having gradually formed into two parcels; the stump was quite open, the bone well covered, and good granulations appearing, with a great discharge of well formed matter.

On the 22nd, his want of strength to carry on the necessary actions became apparent.

On the 24th, he died.

On examining the amputated limb, the popliteal nerve was found untouched, the ball having passed on the inside; the popliteal vein was also entire, having a small tumour adhering to its under part between it and the artery, the divided end of which was closed by a yellowish green firm substance, readily distinguishing it from the surrounding parts. On clearing the whole from the bone, and making a small circular opening into the tumour, which was elastic and covered with brown fibrous layers, it proved to be an aneurismal sac, smooth on the inside, containing florid arterial blood, and some little coagula. The cavity of the sac was not perfectly regular, being nearly divided on one side by a process running into it. The artery, on being carefully opened to the closed end, appeared to have been injured above the part divided by the ball, and communicated with the sac by a small fissure or rupture. The end of the artery was then slit up, so as to show the very little thickness of the closing substance, and the great original contraction of the diameter of the vessel. There was no internal coagulum, neither was there any laid over the external part of the artery; between it and the bone there was a coagulum lying of the size of a small phial cork. Displeased with myself for having listened to Captain St. Pol's petition for delay, which I knew even under more favourable circumstances had been futile, I felt a melancholy satisfaction on viewing the diseased parts, which showed that process of nature in closing the artery completed, which in the former case had only been begun, although a longer period of time had elapsed.

We were inclined to suppose that the aneurismal sac existed prior to and independent of the gun-shot wound, considering that a sac of that nature could not be formed in ten days. Captain St. Pol did not remember any injury to have happened to, or any painful sensation to have existed in the knee before the accident; but Dr. Armstrong recollected his having once or twice mentioned some uneasiness in it, but in so casual a manner as not to have caused further inquiry. The other end of the artery I could not find from the gangrenous state of the parts. He was a remarkably handsome young man, and died beloved and regretted by every one.

Case 24.—Private P. Turnbull, of the grenadiers of the 74th regiment, of good stature, was wounded on the 10th April, 1814, at Toulouse, by a musket ball passing from the inside to the outside of the middle of the thigh; he says it bled considerably at first, but soon ceased; the wound was not painful, and he thinks he observed the leg and foot to be colder than the rest of his body for the first two or three days, but did not much attend to it, further than conceiving the numbness, coldness, and impeded power of motion as natural to the wound.

On the 18th of April the gentleman in charge of this patient pointed him out to me as an extraordinary case of gangrene coming on without any, as he supposed, sufficient cause; the wound on the outside of the thigh, or the exit of the ball, was nearly healed, and that on the inside was without inflammation or tumefaction, and with merely a little hardness to be felt on pressure. The pulsation of the artery could be distinctly felt to the edge of the wound, but not below it; the leg was warm, the gangrene confined to the toes. The artery of the other thigh could be distinctly traced down to the tendon of the triceps. As he was at a small hospital, about two miles from town, on the field of battle, I did not see him until the 20th, and again on the 23rd, when, although the gangrenous portion included all the toes, it had the appearance of having ceased. Satisfied that it would again extend, I left directions with the assistant-surgeon that the limb should be amputated below the knee.

The surgeon, whom I had not seen, and who did not understand the subject, disobeyed the order, conceiving that there must be some mistake. At daylight on the 25th I was greatly annoyed on finding that the operation had not been done, and that the mortification had begun to spread the evening before. It was then too late. On the 26th it was above the ankle, with considerable swelling up to the knee. At night the man died; and the next morning at six o'clock I removed the femoral artery from Poupart's ligament to its passage through the triceps, which part was affected by the mortification.

The ball passed between the artery and vein in the spot where the vein is nearly situated behind it, and adherent only by cellular membrane, through which the ball made its passage, the coats of the vein being little injured, and those of the artery not destroyed in substance, although bruised; it was at this spot much contracted in size, and filled above

and below by coagula, which prevented the transmission of blood, and the vein above and below the wound was filled by a coagulum, and was also impassable. This preparation is unique, and is perhaps the only one in existence proving the elasticity which vessels possess, and their capability of avoiding to a certain extent an injury about to be inflicted upon them. It will be hereafter in the museum of the Royal College of Surgeons, for public inspection.

Case 25.—After the battle of Salamanca, I was requested to see a soldier of the fifth division, who had received a shot in the thigh nearly in a similar place, which had been followed by gangrene of the toes, not extending to the instep. The correctness of my opinions not being at that time acknowledged by my friend the surgeon, who showed the case to me from knowing my desire on the subject, he did not amputate when the mortification began to spread suddenly, and this man also died on the day after that occurrence.

Case 26.—A Portuguese, at the same battle, suffered from a wound of a similar nature, but rather lower in the thigh. The mortification which followed was confined however to the great toe only, and great hopes were entertained that it would not spread, when hemorrhage unexpectedly took place from the wound, and the artery was tied some distance above it. The hemorrhage returned and was suppressed, but the patient sunk and died. On examination it was found that an additional, but this time an accidental error had been committed (I have seen it done since in London), and a large branch from the femoral artery running parallel with it had been tied instead of the wounded artery itself, which had yielded by ulceration, not having been cut in the first instance.

Case 27.—Don Bernardino Garcia Alvarez, captain of the regiment of Laredo, thirty years of age, was wounded at the battle of Toulouse by a musket ball, which passed through the thigh, a little above its middle. The wound was not considered a dangerous one until the 30th, twenty days after the injury, when a considerable bleeding took place; and as the vessel from which it came seemed to be very deeply seated, the Spanish surgeon in charge tied the common femoral artery. I saw the gentleman in consequence of this having been done. The hemorrhage was suppressed by the operation, and the limb soon recovered its natural temperature, but gangrene made its appearance on the great toe on the third day afterwards. It did not seem to increase, but the limb swelled as if nature was endeavouring to set up sufficient action to maintain its life, and this continued until the tenth day after the operation, when he died completely exhausted. On the dissection of the limb, the femoral artery was found to be perfectly sound in every part below where the ligature had been applied. The vessel which bled could not be discovered; but it was certainly a branch from the profunda, and not the femoral itself. In this case the ligature of the femoral artery destroyed the patient, and the practice pursued must be condemned. The gunshot wound should have been largely dilated, at both orifices if necessary, until the wounded vessel was discovered, which was in all probability not completely divided by the ulcerative or sloughing process which had taken place, and its division would in all probability have suppressed the bleeding. I shall refer to this case hereafter.

Cases of wounded arteries were not numerous after the battle of Waterloo, as far at least as they were observed in the hospitals in Brussels and at Antwerp.

Case 28.—In one which occurred in a French prisoner in the Gend'armerie Hospital, and for which the femoral artery was tied, it proved fatal from gangrene of the foot and leg.

Three cases have occurred at the Westminster Hospital under my observation, in which mortification of the leg took place from injury to the popliteal artery. The two first were not under my care, and were both in my opinion lost, in consequence of the early signs of loss of life not being recognised until too late. They both died waiting for the mortification to stop by the establishment of a line of separation between the dead and the living parts, which under similar circumstances rarely takes place. In both these cases the amputation should have been done immediately above the knee, including and removing all the injured parts, and before inflammation had set in to any extent.

Case 29.—A lady suffered from mortification of her right leg, without any obvious cause, and desired my attendance. The mortification resembled so much that which follows a divided artery, that I immediately examined the thigh, and found the femoral artery up to Poupart's ligament had become a hardened cord, without pulsation. She had suffered an attack of inflammation in it. A line of separation having been formed behind the knee, I amputated the thigh immediately above it. The lady died some days afterwards; and the limb and the artery are in the museum of the College of Surgeons.

The result of amputations, after a line of separation had been formed, during the Peninsular war, was not favourable; it was in fact so much the reverse, when the constitution of the sufferer was impaired by disease or was otherwise unsound, that I was led to abandon it in many instances, and to adopt a different proceeding in the following case, which deserves consideration, inasmuch as I have little doubt that death would shortly have followed after an amputation.

Case 30.—Richard Cook, aged fifty, a mason, whilst sitting on a square block of stone, on the 23rd February, was struck by another, which drove the popliteal space or ham against the edge of the block on which he sat, giving him great pain, and otherwise greatly bruising the leg, although no bones were fractured, nor was the skin torn. The limb on his admission, half an hour afterwards,

into the Westminster Hospital, was much larger than the other, and of a dark reddish-blue colour, evidently from the bruise or extravasation of blood, which appeared to be still issuing from the vessel or vessels, as the limb continued to increase in size until it became at last greatly swollen. The pulsation of neither the anterior nor the posterior tibial artery could be distinguished through the swelling the next morning. The bowels were opened, and a cold spirit lotion was applied to the calf, and around the leg, and the swelling somewhat subsided, the limb becoming quite a blue black, which, with the tenseness of the parts, distinctly indicated the effusion of a large quantity of blood. It was soon obvious that greater mischief had occurred than had been expected, and on the 2nd of March, as vesications filled with a bloody fluid were formed on the outside of the leg over the fibula, and the whole limb was manifestly about to pass into a state of gangrene, if it had not already done so, I prepared everything for tying the popliteal or other arteries, if found necessary, and made a long and deep incision on the outer and back part of the leg, through the integuments and muscles, posterior to the fibula, and removed a considerable quantity of coagulated blood from between the muscles and from a large cavity which extended upwards into the ham, without causing further hemorrhage, and in no part of which cavity could an artery be felt. The patient's countenance and body had assumed a jaundiced hue, the pulse was very quick, the tongue foul, the countenance sunken, the skin hot, the head wandering. Poultices of linseed meal and stale beer were applied, with gentle stimulating applications. Brandy and wine were ordered in proper quantity every hour or two, with sufficient doses of the muriate of morphia at night to allay irritation, and induce sleep. The incision, together with these remedies, gave great relief, and on the 7th the man seemed to have been saved from a state of the most imminent danger. On the 8th the pulse was 112, the tongue clean, the skin of a whiter colour, the bowels opened by injections; eight ounces of brandy were given in the twenty-four hours; wine, with sago, arrow-root, jelly, oranges, and anything he chose to ask for. The greatest cleanliness was observed, and the chloride of lime was used in profusion all around him. The mortification of the limb was complete, a line of separation formed about four inches below the knee in front, and extended behind towards the ham. On the 26th, the dead parts having almost entirely separated from the bones all round, those which remained were cut through where dead, and the bones were sawn through about five inches below the knee, and the lower part of the limb removed, leaving an irregular and in part granulating stump, with an inch of bone projecting from it. On the 24th of May this portion was found to be loose; diluted nitric acid had been applied to its surface, and on the 20th of June it separated. On the 16th of August Cook left the hospital in good health, with a very good stump, having cost the hospital £57 in extra diet.

In this case, there can be little doubt of the popliteal artery having been torn, and if the incision made on the 2nd had been had recourse to during the first two or three days, and the artery sought for, and secured if found bleeding, it is possible the mortification might have been prevented, although it is probable, from the pressure arising from the great extravasation and coagulation of blood, that the collateral circulation was so much impeded as not to have been able to maintain the life of the limb below, even during that time. The incision made on the 7th saved the life of the patient by taking off the tension of the part, and relieving thereby in a remarkable manner the constitutional irritation which hourly appeared likely to destroy him; indeed, no one expected anything but his dissolution. When the line of separation had formed, he was evidently unequal to undergo the operation of amputation, to make a good stump without great risk, and the dead parts were therefore merely separated for the sake of cleanliness and comfort. Experience has demonstrated in too many cases of the kind that the formal operation of amputation at this time as recommended by most modern surgeons would in all probability have cost him his life.

Case 31.—In 1834 I placed a ligature of strong dentist's silk on the right common iliac artery of a lady of middle age for a swelling in the hip, supposed to be a gluteal aneurism, and which, after commencing the operation, was found to occupy a considerable part of the iliac region. The lady died a year afterwards, and it was then found that the ligature had been applied at the distance of five-eighths' of an inch from the bifurcation of the aorta, and three-eighths of an inch above the origin of the internal iliac, independently of the line of separation between the parts of the iliac divided by the ligature, and which did not seem to be wider than the ligature itself. The separated ends were united at the point of separation by new matter, the orifice or end of each being closed by a very narrow barrier, the inner coat of the artery being redder than natural, somewhat irregular and contracted, and containing hardly any coagulum, thus proving the fact, in the largest artery in the body save one, that a coagulum is not necessary for the safety of the union, while the immediate vicinity of so large a vessel as the internal iliac, to say nothing of the aorta itself, also proves that the danger hitherto expected from the neighbourhood of a collateral branch is more imaginary than real—two great facts the practice of the Peninsular war led me to declare, and which can no longer be doubted.

The preparation exemplifying these points is in the Museum of the Royal College of Surgeons, together with the ligature, still carrying in its noose the portion of the artery it strangulated and brought away with it.

The mortification of the extremity, which, from what I have said, might reasonably have been expected to take place from a defective or unestablished collateral circulation, was, I apprehend, prevented by keeping up a regular gentle friction, by

the hands of a nurse, on the foot and leg up to the knee, almost without intermission, for the first twenty-four hours, and at short intervals afterwards, until the re-establishment of the circulation could not be doubted. I had previously tried it in a case of inguinal aneurism, for which I had placed a ligature on the external iliac artery, less than an inch from its origin from the common iliac, by a similar operation, not knowing which vessel I should have to tie, from the extension of the tumour upwards, in which case it succeeded equally well; and I am not without hope that if this practice should be duly followed up in all cases of wounded arteries of the lower extremity, and in some of the upper, that the danger from mortification may be greatly obviated.

Some practical deductions may be made from these facts.

1. That the theory of the operation of aneurism, as dependent on the collateral circulation, cannot be applied with safety to spurious aneurisms of recent occurrence dependent on wounded arteries.

2. That it is inapplicable to wounded and bleeding arteries.

3. That the length of time a spontaneous aneurism has existed is of consequence, as connected with the collateral circulation; although an aneurism should never be allowed to attain that size which may render it injurious to the surrounding parts.

4. The collateral vessels are at all times and under all natural circumstances capable of carrying on the circulation in the upper extremity, whatever disease or injury may affect the principal trunk, provided a due degree of care be taken to maintain the temperature of the part. Whenever the reverse takes place, it is an exception to the general rule.

5. After operations for aneurisms in the lower extremity, the collateral branches are almost always equal to carry on the circulation through the limb.

6. When the principal artery of the lower extremity is suddenly divided, without any previous disease having existed, mortification is not an uncommon occurrence, and is more likely to take place in old than in young persons.

7. When under such circumstances the principal vein is also divided, mortification seldom fails to be the consequence.

LECTURE III.

Effects of the application of a ligature; Division of the inner and middle coats; Curling inwards of the inner coat; The inner coats affected by adhesive inflammation; The outer coat yields by ulceration, or sloughing; Contraction of the vessel, and inflammation of its coats above the ligature; Formation of the small tapering coagulum; The coagulum not absolutely necessary to the permanent closure of the vessel; The presence of a collateral branch immediately above the ligature does not always prevent the closure of the artery; The power which suppresses hemorrhage in a bleeding artery, is in the very extremity of the vessel itself; A ligature should be round and small; Strength of the ligature; Selection and proper application of a ligature for unhealthy arteries; Ulceration of the inner coat of the vessel; Occurrence of secondary hemorrhage; Case of wound of the ulnar artery, with ligature of the brachial, terminating fatally; Case of wound of the brachial artery, the vessel tied at the seat of injury, terminating successfully; Case of extensive injury of the anterior tibial artery, with ligature of the femoral, followed by secondary hemorrhage, amputation, and death; Case of wound of the posterior tibial, ligature of the femoral, secondary hemorrhage, amputation, and death; Case of wound of the femoral, the Hunterian operation, formation of an abscess, secondary hemorrhage, amputation, and death; The Hunterian operation not applicable to wounded arteries; Mr. J. Bell's case of wound and false aneurism of the gluteal artery; Mr. Carmichael's case; Professor Baroni's case; Baron Dupuytren on aneurisms complicating fractures, and wounds by fire-arms, and their treatment by Anel's operation; M. Delpech's case; Baron Dupuytren's case of false aneurism from pistol-shot wound of the leg, with successful ligature of the femoral artery; Remarks on his practice; Case of diffused aneurism of the thigh, following fracture of the femur, terminating by fatal mortification; Case of true popliteal aneurism, becoming diffused by rupture of the sac; incision into the false aneurism, amputation, and death; Sir Astley Cooper's case of ligature of the femoral, from wound in the leg, secondary hemorrhage, and amputation; Mr. S. Cooper's successful case of ligature of the femoral, for wound of the leg; Mr. S. Cooper's successful case of ligature of the popliteal artery, for a wound in the calf of the leg; Mr. Guthrie's successful case of ligature of the perineal artery at the seat of injury; Mr. Hall's successful case of ligature of the posterior tibial artery at the seat of injury; Mr. Arnott's successful case of ligature of the posterior tibial artery at the seat of injury; Mr. Roche's case of ligature of the posterior tibial artery for aneurism after amputation; Mr. Collier's case of ligature of the posterior tibial for secondary hemorrhage after hospital gangrene; Mr. Stanley's cases; The operations for placing a ligature on the posterior tibial artery; All such wounds, and all recent aneurismal swellings resulting from them, are to be treated by incision, and the application of two ligatures to the artery.

There are few points in surgery on which a greater difference of opinion has taken place, than on the best manner of placing a ligature on an artery, and on the effects which follow its application.

When a round and small ligature is properly applied to an artery of a large size, such as the femoral, the sides of the vessel are brought together in a folded, plaited, or wrinkled manner; the inner and middle coats of the artery are divided, the outer one remains entire and apparently unhurt. If the ligature be removed, an impression or indentation made by it on the outer coat will remain as a mark; and if the artery be slit open in a careful manner, the division of the two inner coats will be obvious. These changes were known to Desault, and are mentioned by Deschamps in his work on the Ligature of Arteries. They were more satisfactorily proved to occur by Dr. Jones; and have been clearly stated by Mr. Hodgson and others. The remaining part of the process differs from the account they have given, and from observations I have had opportunities of making on the living and the dead, is as follows:—The inner and middle coats are not only divided, but the inner one particularly appears to be curled inwards on itself, so that the cut edge of one half or side is not applied to its fellow in the usual way of two surfaces, but by curling inwards meets its opponent on every point of a circle, and in this way forms a barrier inside that of the external coat, which is tied around it by the ligature: so that in fact when a small ligature is firmly tied, its direct pressure is not applied to the inner coats, which have been divided, and have curled away from it, but to the outer one, which is in consequence of that pressure made to ulcerate or slough, which processes could scarcely fail to take place also in the other coats, if they were subjected to pressure in a similar manner. The cut edges of the two inner coats, being from this provision of nature perfectly

free, are capable of taking on the process of inflammation, which stops at the adhesive stage. This they do by the effusion of lymph or fibrin both within and without, to a greater or less extent as the case may require. The outer coat of the artery must either yield by ulceration or sloughing, or the ligature must remain until it is decomposed and destroyed. The artery usually yields by sloughing, and the ligature is left at liberty by the ulceration which takes place in the sound part of the artery immediately above and below the part strangulated by the ligature, and which part is frequently brought away in the noose. The artery does not always yield by sloughing, particularly if it is a large one, and the ligature has been thick and soft. In this case, a part of the outer coat, from its folding or plaiting under the ligature, seems to escape that degree of pressure necessary to destroy it, and when the remaining part yields, it remains entire, and is only removed by a subsequent process of ulceration, occasioned by its irritation as an extraneous body. I have had the opportunity and the misfortune of examining great numbers of stumps after amputation and death, and I have seen this occur in so many instances as to leave no doubt of the fact.

In these cases, the external coat could not close around the inner ones; and this shows that they are capable of forming an effectual barrier without it, although it materially assists in giving greater strength to the cicatrix, by the effusion of fibrin which takes place within, without, and around.

Whilst this process is going on without, and at the very extremity of the artery, the vessel is gradually contracted above it, and its coats become more or less inflamed, soft, and vascular. The inner coat is seen to be wrinkled transversely, and a small coagulum of blood is formed within it. This sometimes completely fills the artery, but it is more common for a small tapering coagulum to be formed, adhering by its base to the extremity of the inner coat; the white colour of which renders it distinctly observable, when contrasted either with the coagulum, or the inner coat of the artery, which latter is usually of a red or scarlet colour, whilst the inflammatory action is going on. My observations have led me to believe that a coagulum is not absolutely necessary to the permanent closure of the artery, although it certainly assists in maintaining it. An artery is also supposed to contract gradually up to its first collateral branch; but this is not always the case, and depends entirely on the use for which the branch is required. After amputation at the middle of the arm, the artery will go on diminishing in size up to the subscapular branch; the circumflex arteries diminishing in proportion, in consequence of their being so much less necessary than before the operation. I have seen several instances in which the principal artery has remained pervious below the collateral branch, the next immediately above the part where the ligature has been applied. Neither will the presence of a collateral branch immediately above where the ligature has been placed upon the artery always interfere with the consolidation of the wound, and the closure of the canal of the vessel. It may impede the process, and render it for a time less safe, and in some instances prevent it altogether. I have so often seen large arteries heal after division close to the giving off of a considerable branch, that I consider them to be always capable of doing so, provided they are naturally sound. If they are not sound, it is very doubtful what process may take place; but it will be less likely to be a healthy one, if interfered with by the immediate proximity of a collateral branch. The power which suppresses hemorrhage in a bleeding artery, resides however in the very extremity of the vessel itself.

A ligature should always be round and small; provided it be sufficiently strong. The strength of a ligature is variously estimated; some surgeons trying it by the strength of their own fingers, others by what they conceive to be the resisting power of the coats of the artery, in which perhaps they may err. The only way in which a surgeon can hope to acquire correct information on this point, is by trying on the dead body what force of fingers is required to cut the inner coats of arteries of various sizes; and then taking the least force required for this purpose, to ascertain whether he can easily pull the ligature over, or off the divided end of the artery. If a surgeon will take the trouble to do this, he will find that he has estimated the necessary force much too highly, and that he is in more danger by breaking his ligature than of failing to secure the artery. Hemorrhage has however been known to occur from the ligature having slipped off the end of an artery, which had been divided in the operation for aneurism, although I have never seen it happen after amputation, where the vessels were tied with a small firm ligature. It constitutes a valid objection to the division of the artery between the ligatures, when two are applied.

A ligature composed of one strong thread of dentist's silk, well waxed, is sufficiently firm for the largest artery. It does not however much signify what may be the shape, size, form, or substance of ligatures, when they are applied to arteries in a sound state, provided they are not too large, are fairly and separately tied, and with a sufficient degree of force to retain the ligature in its situation until separated by the usual processes of nature, which generally take from fourteen to thirty days for their completion.

When arteries are unhealthy, the selection and proper application of a ligature are points of great importance. A small round ligature should be fairly, evenly, and firmly although not too forcibly applied, without the intervention of any substance whatever between it and the cellular covering of the artery. The secondary hemorrhages, which are recorded by different writers, took place I am disposed to believe, more from the application of improper ligatures than from any other cause; for the inner coat of an artery is so prone to take on the adhesive state of inflammation, that if a strong small ligature be applied in the manner directed, it is more than

probable that the closure of the artery will be effected. Ulceration will however sometimes take place on the inner coat of the vessel, and slowly extend outwards, undoing in its progress any steps which may have been begun for the consolidation of the extremity of the artery. When a secondary hemorrhage does occur from this or any other cause, it is usually from the beginning of the second to the fourth week; but there is no security for the patient until after the ligature has come away, unless it is retained an inordinate length of time from having included some substances which do not readily yield under irritation, such as the extremity of a nerve, or a slip of ligament which is not sufficiently compressed in the noose of the ligature.

Secondary hemorrhage may also take place from the extension of ulceration or sloughing to the artery from the surrounding parts, and perhaps as frequently as from any other cause; but when mortification occurs, there is no secondary hemorrhage, unless in that species which is called hospital gangrene. The advantages to be derived from the application of a strong small ligature, from the least possible disturbance of the surrounding parts, and from absolute quietude, whilst the healing processes are going on, must be so obvious as to require no further observation. Secondary hemorrhage has been shewn to be the consequence of motion of the limb at too early a period; and an undue interference with the ligature, by pulling at it, cannot be too earnestly deprecated, as likely to give rise to it in a similar manner.

The senior Louis in his Memoire sur les tumeurs fongueuses de la dure mére, page 3, published in the Memoires de l'Academie de Chirurgie de Paris, says, "Our knowledge, always too limited, is almost necessarily defective when it is not supported by a sufficient number of facts relating to the same object, which should be examined with the most scrupulous attention in all their different bearings." Sensible of the justice of these remarks, they must be my apology for the production of so many nearly similar cases, under the belief that they are essentially necessary for a due understanding of the subject to which they relate. They are all abridged to the utmost, consistently with a due preservation of their sense and meaning.

The brilliant theory of the cure of aneurism by the Hunterian method, and the more brilliant operations which followed it, superseded and almost obliterated from the minds of modern surgeons the recollection of the ancient method of proceeding with respect to wounded arteries. There was not a single surgeon to be found with the army at the first battle in Portugal in 1809, who doubted for an instant the propriety of its application to them, no matter in what school they had been educated, nor in what country they had practised their profession. I partook of the general persuasion which at that time prevailed in England, but was fortunately on the very first occasion, at the battle of Roliça led to doubt, and shortly afterwards was convinced not only of its inapplicability but of its inefficiency.

Case 33.—Corporal Carter, of the pioneers of the 29th regiment, was wounded at the battle of Roliça in August, 1809, by a musket-ball, which passed through the anterior and upper part of the forearm, fracturing the ulna. Shortly afterwards a profuse hemorrhage took place, and the staff surgeon in charge tied the brachial artery. In the night the hemorrhage recurred, and the man nearly bled to death. The arm was then amputated, when the ulnar artery was found in an open and sloughing state.

Remarks.—A simple incision to expose the wounded artery and to place two ligatures upon it would have saved this man his arm.

Case 34.—At the battle of Vimiera, which followed a few days afterwards, a soldier received a somewhat similar wound, save that the brachial artery bled forthwith, and was only stopped by the tourniquet. Warned by the preceding case, I cut down on the artery, carefully avoiding the nerve, which had been tied in the former instance, and found the artery more than half divided. It was secured by a ligature above and below the wound; the bleeding did not afterwards return, and the man recovered.

Case 35.—Thomas Carryan, of the 3rd regiment, was wounded at Albuhera, on the 16th May, 1811, on the inside of the calf of the right leg, the ball passing out on the fore and outside of the tibia: it bled considerably for some minutes, when it ceased, and the hemorrhage did not return until the 15th of June, on which day a little blood followed the dressings, and increased on the patient making any exertion; so that, on the 4th, the gentleman under whose care he was, tied the femoral artery on the outside of the sartorius muscle, which suppressed the hemorrhage for that day, the limb continuing with little or no interruption of the same temperature to the hand as the other; on the 5th, the original wound had a bad appearance, and some coagulated blood was readily pressed out of it; on the 6th, a greater quantity came away; and, on the 7th, the exertion of using the bed-pan was followed by a stream of arterial blood, which ceased on tightening the precautionary tourniquet.

The limb was amputated above the ligature on the artery. Its dissection showed the anterior tibial artery to have been destroyed for some distance and the muscles on the back part of the leg nearly in a gangrenous state. The patient died a few days afterwards.

Remarks.—If an incision had been made on the leg so as to expose the artery, and a ligature had been placed above and below the wound, the man would not have died, as far as surgery was concerned.

Case 36.—A private of the 5th division of infantry received a wound at the battle of Salamanca, from a musket ball, which passed across the back part of the right leg, from above downwards and inwards. It entered about two inches below and behind the head of the fibula, and passed out near the inner edge of the tibia. There was little blood lost at the time, and it was considered to be a simple wound;

eight days after the injury, some blood flowed with the discharge; this increased during the night, and on examining the limb on the morning of the ninth day, it was evidently injected with blood, which flowed of a scarlet colour from both orifices. It being doubtful which vessel was wounded, whether it was the trunk of the popliteal artery, or the posterior tibial or peroneal after its division into these branches, it was thought advisable to place a ligature on the femoral artery about the middle of the thigh, which suppressed the hemorrhage. The case was now shown to me, as one in proof of the incorrectness of the opinion I had a few days before stated, of the impropriety of such an operation being done. The seeming success did not long continue; hemorrhage again took place from the original wound, and the limb was then amputated. The posterior tibial artery had been injured, and had sloughed. The man died.

Remarks.—A straight incision directly through the back of the calf of the leg of six inches in length, and two ligatures on the artery, would have saved this man's leg and life.

Case 37.—James Murphy, of the 28th regiment, twenty-two years of age, was wounded at the battle of Waterloo by a musket ball, which passed through the thigh below its middle and in the course of the femoral artery, which was not, apparently, wounded at the time; but as the wound began to heal, it gave rise to an aneurismal swelling in the part, for which the usual operation for aneurism above the seat of injury was performed by Staff-surgeon Cole, on the 22nd of July, 1815, two ligatures being placed below the artery, which was divided between them.

On the 11th of August, matter was evidently collecting in the thigh, and on the 13th a counter opening was made at the inferior part of the thigh, in the line of the aneurismal tumour, and over the exit of the ball, and two ounces of a bloody purulent fluid were evacuated; four ounces of blood were lost in the evening from the wound.

25th. This morning, on rising to get out of bed, an arterial hemorrhage took place from the counter opening to the amount of about four ounces; pressure on the thigh by the tourniquet could not stop it, but it was arrested by compress and bandage, and the application of cold. The thigh in the evening appeared to be swollen.

26th. The bleeding recurred this morning, but was again arrested by pressure, but the thigh is enlarged and seems injected with blood. Amputation was now determined upon, and performed. The man sunk and died two hours and a half afterwards.

Dissection.—An incision was made in the direction of the aneurismal wound about an inch deep, which exposed the sac, containing a large quantity of coagulated blood of a dark colour, although destitute of fœtor; the blood was not confined to the sac, but was extravasated throughout the limb, the quantity altogether being at least one pound and a half. Another incision was made towards the knee, somewhat in the direction of the artery; and upon opening the tumour, which was beneath the fascia, there spouted out three ounces of thin matter of the colour of clay. No communication whatever could be found between this abscess and any other part.

The ball had passed through the rectus, vastus internus, and sartorius muscles, beneath the abscess but higher in the thigh, and immediately over that part of the artery which was diseased, but did not touch it, although it was the cause of disease in the parts around the artery and of the vessel itself, but the injury was not sufficient to bring on immediate hemorrhage. The artery was affected by extension of disease to it, and not by the direct contact of the ball, in the track of which nothing peculiar was observable. It communicated with the counter opening, and with that part where the blood was first effused.

Remarks.—The great error lay in making a new wound, and in tying the femoral artery as for an aneurism, instead of laying open the swelling. If this had been done, the man's leg and life in all probability would have been saved.

The Hunterian theory, the cause of death in these three men, as well as in many others before and since, is founded on the fact that the artery is, and has been for some time, in a diseased state immediately above and below the aneurismal sac—that if the sac were opened, or caused to inflame or suppurate, the artery could not be safely tied where it was diseased; that it is more likely to be found in a sounder state at some distance from the aneurismal tumour; that the operation is more simple when performed on parts in a healthy and natural state; and that the impetus of the circulation being taken off by the ligature, the blood in the shut sac would become stagnant, and consequently coagulate, and be ultimately absorbed. When the theory is applied to the treatment of a wounded artery, even with a narrow, much less an open wound, the absence of a sac to receive any regurgitating blood from the collateral or capillary vessels is overlooked, together with the hemorrhage which must necessarily follow from the want of such a retaining membrane, unless the divided ends of the vessel should have been closed by some accidental rather than expected process of nature, before the collateral or capillary circulation could become efficient. The previous soundness of the artery at the part injured is overlooked; the danger of mortification from a deficient collateral circulation is contemned, and even if the external wound should have closed, which is not commonly the case, the fact of its being a spurious diffused aneurism, without a sufficiently restraining sac, is neglected. The unaccountable and absurd fear of hemorrhage on opening such a sac, after the numerous instances which are recorded proving its unworthiness, is only equalled by the no less strange and more unaccountable fear which still pervades the minds of many surgeons, of cutting through muscular fibres in order to expose an artery. These apprehensions are so truly ludicrous, that it appears to me almost

incomprehensible, that they can have been so long entertained by able anatomists and surgeons. Nevertheless, they are the only reasons which can be given for placing a ligature on the internal iliac for a gluteal aneurism following a wound, or indeed on any other artery which has suffered a similar injury.

In order to make the necessity for abandoning all fear of hemorrhage from such aneurismal swellings manifest, and to show how imperative it is that even whole muscles should be divided, if they interfere in the progress of an operation, I shall first take into consideration wounds of the arteries of the hip and of the leg, and of the aneurismal swellings to which they may give rise.

Mr. J. Bell was the first to set the memorable example of dividing a large portion of a muscle to enable him to reach a wounded gluteal artery which he did not think he could attain by any other means. His vivid description of an incision of eight inches long, afterwards said to be enlarged to two feet (in what direction is not stated), the removal of eight pounds of coagulated blood from the sac, the deluge of fresh arterial blood which followed with a loud whizzing noise, after all which the patient recovered, ought to have allayed the apprehensions of the most timid surgeons; and although Mr. J. Bell's dramatic sketch of his leech catcher's case may be somewhat exaggerated, it ought to have made surgeons think more on these points than many appear to have done or even to do; and it should have induced them to perform such operations sooner, when the parts would be less distended, and more readily distinguishable.

This operation has since been done by Dr. Murray in Spain, Messrs. Rogers of the United States, Carmichael of Dublin, and Baroni of Bologna; and as the operations performed by the two last are as simply described as Mr. J. Bell's is fearfully related, I shall give them as shortly as possible.

Case 38.—Lieutenant Colonel M'Pherson, 92nd regiment, received a wound from a musket-ball on the 13th of December, 1813, which entered a little in front of the trochanter major of the left side, struck the os femoris which flattened it, passed underneath the glutæi muscles, along the ilium for about three inches, and lodged in the posterior part of the gluteus maximus, whence it was cut out next day. He continued to go on well and to recover his strength till the 27th of December, when he began to complain of pain and heat deeply seated in the wound, and was a little feverish and restless, for which he took a purgative and opiate at night, but without relief. On the 28th, the parts were observed to be more swollen, the pain was increased, and about noon a sudden and violent hemorrhage ensued from the posterior wound, by which in two or three minutes he lost upwards of two pints of blood. Compression was made on the mouth of the wound for some time, which restrained the flow of blood externally; but it appeared that hemorrhage was still going on internally. A firm hard compress of paper rolled up in a bandage was placed along the course of the posterior part of the wound, and bound tightly on it; the parts were kept very cool with vinegar and water; and gentle manual pressure, by a relief of servants as they became tired, was kept constantly on the pad, with a view to obliterate the artery. In the afternoon, a swelling about the size of an egg in extent, but not so thick, was observed to be forming below the pad, two inches from the orifice of the wound; he had for some time begun to feel a gradual increase of pain from the pressure, and whilst changing his posture in bed, the orderly removed his hand for a moment, when another gush of coagulated and of arterial blood escaped, which weakened but gave him ease.

29th.—The parts were considerably swelled, tense, and of a glazed appearance about the centre of the course of the wound; and some blood forced its way out by the anterior orifice, to which an additional compress was applied. About four o'clock in the morning of the 31st, the pressure having been removed, as he was not able to endure it on account of the dreadful pain it gave him, another profuse hemorrhage took place; which reduced him so much that his extremities became quite cold, his countenance pale and shrunk, and his pulse was hardly to be felt. It was stopped as before. In the course of some hours he recovered his warmth, his pulse rose, he became tolerably hearty again and took some breakfast, but as it was evident that the bleeding was going on internally, at eleven, a.m., the operation for placing a ligature on the wounded vessel was performed by Staff-surgeon Murray. A large mass of coagulated blood forced its way out as soon as the incision was made, and was followed by florid arterial blood. The wound was immediately sponged out, and the pressure of two pads which had been placed on each side of the incision, having been removed a little, two large branches of the gluteal artery which had been cut in the first incision, presented themselves, and were secured. The parts were again cleaned out by a sponge; and in the course of the original wound, a large artery was found close upon the bone, from which all the secondary bleedings had taken place; it was included in a ligature, and all bleeding from that part entirely ceased. Its opposite orifice appeared to have been included in a second ligature, as the needle was passed nearly quite down to the ilium. Two other small muscular branches were afterwards taken up, and the lips of the wound then brought together by slips of sticking plaster, with a compress of lint on each side, and a flannel bandage to support the whole. Although he did not lose above four ounces of blood directly from the arteries by the operation, he became much exhausted before it was finished, and indeed we were not without some fears that he would have sunk during its performance. Fifty drops of laudanum were given to him, and he was left on his bed where the operation was performed. For some time he suffered from that anxious restlessness attendant on exhaustion and extreme debility, and from pain and

irritation; but when by rest and a little nourishment the powers of the system began to recover from the shock, the equilibrium of the circulation to be restored, and the opium to exert its influence, he became very composed and easy; his pulse got up; his countenance recovered a degree of vivacity; he said he felt himself much better than before the operation, being more free from pain in the seat of the wound, and his mind was more at ease from the idea of the vessel having been secured; he got a tolerably refreshing sleep of three or four hours, interrupted only at intervals by starting.

January 1st, 1814.—He passed a tolerably easy night, slept at intervals, and took a little nourishment, but had also symptoms of great exhaustion with alternations of chills and flushings, and clammy perspirations, and now and then sickness and hiccough. The parts about the wound were comparatively easy, but hot; there was no oozing of blood; he took a mouthful of toast with a dish of tea to breakfast, was in good spirits, but inclined to doze and sleep much. During the day his appetite failed. Towards evening he began to sink very rapidly, and died at eleven o'clock, p.m.

Remarks.—On examining the state of the parts after death, it was found that no adhesion had taken place. It is evident that the operation ought to have been done in the first instance. The only cause of delay arose from the thickness of the muscular parts to be divided, and the dread which at that period filled the minds of most surgeons upon this subject—a dread which it is to be hoped will be for the future abandoned.

Case 39, by Mr. Carmichael.—Master West, aged seventeen, eleven days before my visit received accidentally a wound of a penknife on the right hip, which penetrated as far as the handle would permit it to go. An immediate gush of blood followed, so strong as to dash against the wall of the chamber near to which he was sitting. Three days afterwards the patient imprudently walked down stairs, but had scarcely returned to his room when he felt an acute pain in the hip, followed by an immediate tumefaction, which increased from day to day. The small cicatrix of the wound was situated about half an inch above the presumed situation of the upper margin of the ischiatic notch, where the gluteal artery emerges from the pelvis. No pulsation was evident to the eye, even on the most minute examination, but the strong pulsation of an aneurismal tumour was manifested to the ear, either by immediate or mediate ascultation. It was evident, therefore, that the tumefaction of the hip did not depend upon the presence of matter, notwithstanding the patient had been affected with frequent rigors from the period that the swelling took place, accompanied by a foul tongue and symptomatic fever; but that it was owing to an effusion of blood in consequence of a wound of the trunk of the gluteal artery, or one of its largest branches.

As I had known instances of wounds of large arteries healing under similar circumstances, although the limb was injected with blood, I deemed it right to give this patient a similar chance before recourse was had to operation. I therefore directed ten ounces of blood to be taken from his arm, as the tumour was painful, and the pulse quick and hard. Draughts containing tincture of digitalis were given every sixth hour; a cold lotion was applied to the tumefied parts, and absolute rest in the recumbent position enjoined. This plan, with occasional opiates to meet pain and uneasiness, was persevered in during five days, but no benefit was derived. On the contrary, the tumefaction of the hip and entire limb was obviously increasing, and an operation was necessary. The patient being placed upon a table, lying on his face, I commenced by making an incision five inches in length, beginning an inch below the superior posterior spinous process of the ilium, and about the same distance from the margin of the sacrum, and continued it in a line extending obliquely downwards to the trochanter major. The gluteus maximus and medius were then rapidly divided, or rather their fibres separated (as the incision ran in the direction of the fibres), to the same extent as that of the integuments. The coagulated blood forming the tumour then became apparent through the sac or condensed cellular membrane with which it was covered. This was divided the whole extent of the incision by running a buttoned bistoury quickly along the finger introduced into the sac, and its contents, consisting of from one to two pounds of coagulated blood, were emptied rapidly out with both hands into a soup plate, which it completely filled. A large jet of fresh blood instantly filled the cavity I had emptied; but the precise spot from whence it came being perceived, I was enabled by pressure with the finger, to prevent any further effusion, while that which had been just poured out was removed by the sponge. It was obviously the trunk of the gluteal artery, just as it debouches from the ischiatic notch, which had been wounded. I endeavoured, but in vain, to secure the artery by means of the tenaculum. I had then recourse to a common needle of large size, and with this instrument was immediately successful in passing a ligature around the bleeding vessel, and in preventing all farther hemorrhage. After having waited some little time to ascertain if the artery was perfectly secured, lint was introduced to the bottom of the wound, as it was not likely that union by the first intention would take place between the walls of the extensive cavity which contained the coagulated blood. The patient was then put to bed, and an anodyne given to him. Everything went on favourably after the operation. On the third day the external dressings were removed; on the fourth the greater part of the lint with which the wound was filled came away, followed by a flow of matter of a good quality. On the sixth the ligature came away as well as the remainder of the lint. From this period the matter continued daily to diminish, and the patient recovered.

Case 40.—Professor Baroni, of Bologna, was called to a young man who was wounded in the

right hip by a fall from a tree on his own pruning-hook, which divided the glutæi muscles, laying bare the sacro-sciatic ligaments and the bone. The edges of the wound united, but an abscess formed, requiring to be evacuated. The fourteenth day after the accident two most serious hemorrhages took place, which were restrained by compression. The wound being laid open, and the coagula removed, a jet of arterial blood marked the situation of the gluteal artery, the upper end of which was tied by the professor; but as the bleeding continued from the opposite end, a ligature was also placed on it, and the man recovered in a month.—*Gazette Médicale*, p. 695, 1835.

Remarks.—These cases are quite decisive as to the practice which ought to be pursued in wounds of the gluteal or of the sciatic arteries, or in aneurismal tumours, the consequence of wounds, in preference to placing the ligature on the internal iliac artery, as in a case of aneurism formed from disease of the coats of the vessel; to which operation, in such cases, the only real objections are, that the patient is likely to suffer from peritoneal inflammation, and that the operation is one of some difficulty, requiring a great degree of dexterity, and of anatomical knowledge.

The Baron Dupuytren in 1828 published a paper entitled "Memoire sur les Aneurismes qui compliquent les fractures et les plaies d'armes à feu et sur leur traitement par la ligature pratiquée suivant la methode d'Anel," in the *Repertoire General d'Anatomie et de Physiologie*, which operation he recommended as superseding that of amputation, which, up to that time, he says, had been usually performed in France in such cases, and with the view of avoiding the operation I had proposed some years before on the part injured, by cutting through the intervening muscular fibres. The operation the baron did was that of Hunter, and not, as he states, that recommended by Anel, who never performed one on that principle. A strange error for the baron to have fallen into, but no less so than the statement made at page 22 that he had consulted in vain both ancient and modern authors on this subject, although Breschet had translated Mr. Hodgson's work on the Diseases of Arteries nine years before, in which my earliest cases were especially noticed. His memoir shows, at all events, that the practice the Baron Dupuytren recommended to the surgeons of France in 1828 as worthy of their adoption, had been tried by many of the surgeons of the British army in 1811 and 1812, and found wanting, and is an honourable testimony to their labours. The baron supports his views by the relation of seven cases, which I have transcribed in my work on this subject, although two only bear effectually upon it. One is by Delpech, the other by himself. In Delpech's case (No. 41) the patient, Jacques Boudet, thirty years of age, had his left leg broken (a comminuted fracture) on the 8th of May, 1815, by the wheel of a car laden with hay. On his arrival at the Hospital St. Eloi, M. Delpech found the limb enormously swollen, and this swelling was accompanied by pulsations, which were very distinct near the calf, and more or less perceptible when pressure was made on or removed from the above artery. The femoral artery was tied next day, and the patient recovered, and was discharged cured on the eighty-second day.

Remarks.—In this case it was not known whether the anterior or the posterior tibial artery was wounded, or the femoral, or all three, or the popliteal alone. An incision made, even in the right place, must have made a comminuted fracture a compound one, and greatly endangered the life of the patient. The operation was therefore a fair experiment, and if it failed, amputation was still a resource before mortification had taken place. It is not exactly a case in point.

The baron's seventh case, that of Captain de Gambaud, fairly however meets every point, and as far as it goes fully establishes his opinion.

Case 42.—"M. de Gambaud received, February 10th, 1818, a wound from a horse pistol, which entered the upper part of the right leg, from the front backwards, and from the outside inwards, passing between the tibia and the fibula, which latter it slightly injured. A violent bleeding immediately ensued. A young surgeon stopped the hemorrhage by the application of a compress and bandage. The leg became swollen and very painful, to which succeeded an alarming numbness; nevertheless life remained in the limb, and no outward bleeding occurred till the thirteenth day; but during this time an internal effusion had taken place, and an aneurism was developed, which increased every day, and became more observable from its synchronous movements of expansion and contraction with those of the pulse.

"The bleeding was renewed several times in a few days, and greatly weakened the patient, in spite of the assistance, both internal and external, which was afforded him. The foot and leg were of a violet colour, swollen, cold, and numb. On the upper part of the leg there was a swelling accompanied by tension, and a movement of expansion and contraction, synchronous with the action of the heart. There were two small round openings with unequal edges on this tumour, situated the one at the back of the leg near the fibula, the other on the inner edge of the calf. The first was where the ball entered, and the second where it came out. They both for a few hours had been closed by clots of blood, that each pulsation threatened to raise and force out. A tourniquet applied to the lower part of the thigh on the course of the femoral artery, would of course lessen the impulse of the blood, but could not prevent its getting to the tumour, and giving rise to frightful shocks.

"Such was M. de Gambaud's state; the wound that he had received, the first hemorrhage that he had sustained, the tumour which had been formed from the first moment that the blood had ceased to flow outwardly, the volume and tension of this tumour, the nature, extent, and strength of its movements, the repeated bleedings that the patient had suffered, all proved that the ball had destroyed

one or several of the great arterial trunks in the ham.

"What was to be done? We could not again make use of compression, which had already been fairly tried, and had not prevented five or six hemorrhages taking place, which had reduced the patient to an alarming state of weakness. Ought we to place a ligature on the extremities of the divided vessels?

"But what were those vessels? Was it the anterior or posterior tibial artery, or the peroneal, or the popliteal artery, or was it several of these at the same time? If it were one or more, how should we attack them, before or behind, or on these two points successively?

"But to all who know the depth at which these vessels are situated, their relation to the bones, muscles, and nerves, this project appears impracticable. Could we even determine exactly, which was impossible, which vessel was injured, how could we get at it? How could we distinguish it from the soft, torn, and bruised parts which would surround it? or how would the instruments and the threads necessary to tie a ligature be got to the bottom of a wound thus deep, and between the bones? The amputation of the thigh seemed the most prompt and safe remedy; and this was what my young colleagues wished, and only waited for my sanction to perform. Amputation is not, however, without danger, and in my opinion will kill three out of twelve, when practised even upon young and healthy persons, such as are chosen for its victims on the field of battle. I did not therefore recommend that it should be had recourse to, but advised the placing of a ligature on the femoral artery. If the event did not turn out as I expected, if the blood brought back by the collateral arteries continued to flow either at the superior or inferior extremity of the divided artery, or if from any other cause the ligature should prove insufficient, it would become the first part of an amputation, neither more dangerous nor more painful from being performed at two intervals. The operation was performed in one minute. It proved successful, and M. de Gambaud was quite cured in three months."

To support his opinion that this case should lead the way towards erecting the practice pursued into a precept in surgery, he is forced to consider certain points as facts, which have never been demonstrated to be facts; but I shall give his own words:—

"The ligature, in suspending the course of the blood in a divided vessel, the solution of continuity of which has caused an external and internal bleeding, gave time and means to the inflammation to cicatrise the wounds in the vessel, and to render the cut extremities impermeable to the blood which the anastomosing branches might bring to them.

"To judge by analogy, this obliteration ought to be more easy and more certain after a gunshot wound than any other.

"One of their most remarkable effects is to contract (*froncer*) the orifices of the vessels, to concrete or coagulate the blood contained in their extremities, and to render them impervious."

Remarks.—This last passage cannot be admitted as a correct statement of the effects of a gunshot wound on arteries.

I have shown in the preceding observations the real effect of a ball on the extremity of a divided artery, and that the appearances depend very much on the size and structure of the vessel. In what manner the ball can contract (*froncer*) the orifices of an artery has never been shown, neither can it be easily understood, inasmuch as the act of contracting must be a vital act dependant on the powers of the artery itself. If it be a mechanical act, arising from injury, it must be a contusion; and this cannot be advanced as a process likely to consolidate the end of the vessel, it being now well known that the first and most simple state of adhesive inflammation is the best calculated for promoting the permanent closure of a divided artery.

When a wounded artery has been tied at a distance from the wound, as in the case of M. Dupuytren, it is certainly true that if the blood can be prevented by this means from passing into the divided vessel, there will be a greater chance of the natural processes of inflammation and granulation which are taking place in and around it, closing it up, than if the blood be allowed to flow through it. But it is only then a chance. It is impossible to calculate the time which nature may require to bring the blood by the collateral vessels into either the upper or the lower end of the vessel; it may occur immediately; it may not do so for hours or for days, and on the speculation that it may not do so, the first hope of safety depends—the second on the further accidental circumstance that the end of the artery may be closed in the interval. Surely this cannot be considered a scientific operation, and fit to be erected into a precept in surgery, which depends on two accidental circumstances, neither of which can in the slightest degree be calculated upon.

There are many other reasons why the operation was a bad one in this case, and always will be a bad one in all similar cases. The patient was made to undergo the chance of mortification of the extremity, which it is probable would have taken place, if the operation had not been delayed until thirteen days after the first hemorrhage occurred from the wound, during which time the inflammation in the limb had given the collateral vessels a disposition to enlarge. The wound itself was not treated as the principles of surgery require. A quantity of decomposed blood was pent up under and between the muscles of the calf of the leg, together with some of the patient's clothes, and some spiculæ of bone. In a case like this, unattended by the fear of hemorrhage, the baron would have enlarged the wound, cleared away the clots of blood, and have placed it in a simple state. There cannot be a doubt on the subject, and the operation of making an incision through the muscles of the calf of the leg would have enabled him to do all this, and to have secured the vessels, if there had been even four bleeding extremities, without any difficulty or danger.

The Baron Dupuytren applied Mr. Hunter's theory of the operation for aneurism to the treatment of a wounded artery, and succeeded by chance. Others have done the same long before him; but nothing which is dependent on chance or accident can ever become a principle in surgery, and I understand the baron became so thoroughly convinced of this before his death, that he at last advocated the principle that a wounded artery should be tied at the injured part, and not at a distance, in opposition to the then generally received opinions in France.

Case 43.—A gentleman was thrown from the top of a coach at Chatham, and suffered a severe injury of the thigh, which broke the bone. No further injury was suspected, until a tumor formed at the lower and internal part of the thigh, and the toes began to turn black and to mortify. My opinion was now desired, and my reply was, amputate the limb, or you will lose your patient by the extension of the mortification, which eventually occurred.

Remarks.—If the mortification had not taken place, the surgeon could with propriety have awaited the progress of the diffused aneurism, there being no external wound. If it continued, and remained stationary, or only slowly increased during weeks, the operation for its cure by ligature of the artery above would have been a fair experiment. If, on the contrary, the aneurismal swelling increased rapidly, or the consolidation of the fracture did not take place, amputation was the safest resource.

Case 44.—A man was admitted into the Westminster Hospital, under the care of Sir Anthony Carlisle, having had a beating tumour in his ham, which had suddenly disappeared on something apparently giving way in his leg, which caused it to swell to nearly double the size of the other, from immediately below the knee to the ankle. There was no doubt in my mind of its being a diffused aneurismal swelling from rupture of an aneurismal sac, and I suggested the propriety of placing a ligature on the femoral artery, as for an ordinary aneurism, and awaiting events; such as laying open the soft parts of the leg for the evacuation of the coagulated blood, or of the matter which might form, or to make the ligature of the artery the point of amputation, if gangrene should supervene. Sir Anthony Carlisle preferred laying open the leg at once; this he did by an incision through the calf of the leg, opening into a largely dilated and ruptured sac, formed at the origin of the posterior tibial artery. The coagula being removed, the popliteal artery bled vigorously; the anterior tibial opening into the sac did the same, and the lower end of the posterior tibial poured out arterial blood even more vigorously than the anterior tibial. Sir Anthony Carlisle decided on amputating the limb, which he did, and the patient died.

Remarks.—If this diffused aneurismal swelling had followed a wound inflicted some two or three weeks before, the three bleeding arteries and the effused blood would not have rendered amputation admissible unless mortification supervened. It was the previously diseased state of the artery which had led to the formation of the aneurism that induced me to recommend that it should be tied in the thigh as an experiment, and after the diseased artery with its sac, &c., had been laid open, that the limb should be amputated.

Case 45.—Sir Astley Cooper at one time shared in the same opinion as Dupuytren, and tied the femoral artery for a wound in the leg below the knee. Mr. Green, who was present, informs me that the bleeding returned, and the limb was amputated, and Sir Astley, I know, abandoned both the theory and the practice.

Case 46.—Mr. S. Cooper did the same thing at Brussels after the battle of Waterloo, and succeeded; but he admits in his Dictionary, article "Arteries," that he succeeded only because the collateral branches did not re-establish the circulation in the lower end of the artery, or that it had been closed in time to prevent it when they had done so. This was an operation successful by chance, and not on principle. Mr. S. Cooper did better in 1834, in the following:—

Case 47.—The man had a wound in the calf of the leg, and the house-surgeon of University College Hospital having failed after several trials to secure effectually the wounded artery, he (Mr. Cooper) tied the popliteal, and succeeded. In this case he descended from Hunter to Ancl, but this also only succeeded by accident, and another operation would have been required if the collateral circulation had been early restored, whereas a single straight incision through the muscles of the calf would have enabled him to tie all the cut vessels, even including the popliteal, or principal trunk. I am quite satisfied that if another case of the kind should occur to the learned professor of surgery, he would tie the artery above and below the part injured, and by the operation I shall show you has succeeded so well.

Case 48, by Mr. Stanley.—A butcher in slaying an ox received a wound on the inner side of, and about two-thirds down the leg; the length of the wound was not more than half an inch, but it penetrated from the inner almost to the outer side of the leg, and deeply in the direction of the posterior tibial and peroneal arteries. Profuse arterial bleeding immediately ensued. A bandage was placed around the leg, which was not disturbed for eight days; then, on removing it, the hemorrhage returned. He freely enlarged the wound, and exposed the posterior tibial artery, which was of unusually small size, and was partially divided. He placed two ligatures around the artery, one above and the other below the wound in it.

Much constitutional derangement followed, with inflammation of the absorbents up the thigh. This was succeeded by an attack of delirium tremens, from which the man sunk on the fifteenth day from the receipt of the wound; but there was no return of bleeding after the ligature of the posterior tibial artery.

On examining the limb, the posterior tibial artery throughout was found to be not more than half its

usual size. The peroneal artery in its whole length was more than twice the size of the posterior tibial. It was found that the knife in its passage through the leg, having partially divided the small posterior tibial artery, had also penetrated the large peroneal artery at a point where it was very deeply situated, in a hollow between the fibula and the inter-osseous ligament, but which had not bled.

Case 49, by Mr. Stanley.—A boy, ten years of age, in walking, slipped his foot through a pane of glass, which wounded the inner side of the leg in the hollow between the inner malleolus and os calcis. Profuse bleeding immediately ensued, which was stopped by a bandage. Three days afterwards the removal of the bandage was followed by a flow of arterial blood. He enlarged the wound, exposed the posterior tibial artery, and observed a hole in the side of it, from which the blood issued. He placed two ligatures around the artery, about an inch distant from each other, the one clearly above, the other below the orifice in the vessel. About an hour afterwards the arterial bleeding returned, and on sponging out the wound, to his surprise, he found that the blood escaped from the hole in the side of the artery. He then placed two additional ligatures around the artery close to the hole in it. There was no return of the hemorrhage.

Remarks.—It was presumed that a branch had conveyed the blood into the artery in the interspace of the two ligatures which were first applied. This case is most valuable and important.

The following case was published by me in the 7th vol. of the "Transactions of the Medico-Chirurgical Society":—

Case 50.—Henry Vigarelie, a private in the German legion, was wounded on the 18th of June, at the battle of Waterloo, by a musket ball, which entered the right leg immediately behind and below the inner head of the tibia, inclining downwards, and under or before a part of the soleus and gastrocnemius muscles, and coming out through them, four inches and three quarters below the head of the fibula, nearly in the middle, but towards the side of the calf of the leg. In this course it is evident that the ball must have passed close to the posterior tibial and peroneal arteries; but as little inflammation followed, and no immediate hemorrhage, it was considered to be one of the slighter cases. On the latter days of June he occasionally lost a little blood from the wound, and on the 1st of July a considerable hemorrhage took place, which as suppressed by the tourniquet, and did not immediately recur on its removal. It bled however at intervals during the night; and on the morning of the 2nd it became necessary to re-apply the tourniquet, and to adopt some means for his permanent relief.

The man had lost a large quantity of blood from the whole of the bleedings, his pulse was 110, the skin hot, tongue furred, with great anxiety of countenance: the limb, from the application of the tourniquet from time to time, was swelled, a quantity of coagulated blood had forced itself under the soleus in the course of the muscles, increasing the size of the leg, and florid blood issued from both openings on taking the compression off the femoral artery. On passing the finger into the outer opening, and pressing it against the fibula, a sort of aneurismal tumour could be felt under it, and the hemorrhage ceased, indicating that the peroneal artery was in all probability the only vessel wounded.

In this case there was, in addition to the wound of the artery, a quantity of blood between the muscles, which in gun-shot wounds accompanied by inflammation is always a dangerous occurrence, as it terminates in profuse suppuration of the containing parts, and frequently in gangrene. Its evacuation therefore became an important consideration, even if the hemorrhage had ceased spontaneously.

The man being laid on his face, with the calf of the leg uppermost, I made an incision about seven inches in length in the axis of the limb, taking the shot hole nearly as a central point, and carried it by successive strokes through the gastrocnemius and soleus muscles towards the peroneal artery, which I attempted to discover, but this was more difficult than might be supposed, after such an opening had been made. The parts were not easily separated, from the inflammation that had taken place, and those in the immediate track of the ball were in the different stages from sphacelus to a state of health, as the ball in its course had produced its effect upon them, or their powers of life were equal or unequal to the injury sustained.

The sloughing matter mixed with coagulated blood readily yielded to the back of the knife, but was not easily dissected out. The spot which the arterial blood came from was distinguished through it, but the artery could not be perceived, the swelling and the depth of the wound rendering any operation on it difficult. To obviate this inconvenience, I made a transverse incision outwards, from the shot hole to the edge of the fibula, which enabled me to turn back two little flaps, and gave greater facility in the use of my instruments. I could now pass a tenaculum under the spot whence the blood came, which I raised a little with it, but could not distinctly see the wounded artery in the altered state of parts, so as to secure it separately. I therefore passed a small needle, bearing two threads, a sufficient distance above the tenaculum to induce me to believe it was in sound parts, but including very little in the ligature, when the hemorrhage ceased; another was passed in the same manner below, and the tenaculum withdrawn. The coagula under the muscles were removed, the cavity washed out by a stream of warm water injected through the external opening, the wound gently drawn together by two or three straps of adhesive plaster, and the limb enveloped in cloths constantly wetted with cold water. The patient was placed on milk diet.

On the 4th, two days after the operation, the wound was dressed and looked very well; the weather being very hot, two straps of plaster only were applied to prevent the parts separating. On

the 5th, a poultice was laid over the dressings, in lieu of the cold water, the stiffness becoming disagreeable. On the 6th, as the wound, although open in all its extent, did not appear likely to separate more, the plasters were omitted, and a poultice alone applied. On the 8th and 9th it suppurated kindly; and on the 10th, or eight days from the operation, the ligatures came away, the limb being free from tension, and the patient in an amended state of health, his medical treatment having been steadily attended to.

From this period the cure went on, although slowly, without accident; a small abscess formed at the inner and lower edge of the soleus muscle, but closed shortly after its contents were evacuated. The wound was entirely healed in three months, but the leg was bent on the thigh, and required mechanical means for its extension.

The length of the fibula is sixteen inches. The cicatrix of the wound made by the ball is four inches and three quarters below the head of the fibula. The sound limb, four inches and three quarters from the head of the fibula, is thirteen inches and three quarters in circumference. The limb operated on eleven inches and three quarters, being a diminution of two inches. The length of the cicatrix is six inches and a half. The peroneal artery was tied therefore by computation one inch and a quarter below where it is usually given off by the posterior tibial.

The man was brought to England to the York Hospital at Chelsea, and walked about without appearing lame, although he could not do so for any great distance. He suffered no pain, except an occasional cramp in the ball of the foot, and some contraction of the toes, which took place generally when he rose in a morning, and continued for a minute or two, until he put them straight with his hand; this I did not attribute to the operation, but to some additional injury done to the nerves by the ball in its course through the leg.

Mr. Hall, of East Retford, has published the following case in the *London Medical Gazette*, of the 6th February, 1846:—

Case 51.—April 16, 1841. A gentleman, upwards of sixty, had been thrown from his horse, and was reported to be bleeding to death from a wound of the leg. In less than half an hour after the infliction of the injury, his clothes were saturated with blood, and a considerable quantity had flowed into his shoe. He was cold and faint, with a feeble pulse. A little brandy and water were immediately given to him, and he was placed in bed. On removing his clothes, a wound of about an inch in length was seen in the calf, a little below the junction of the upper with the middle third, and from which the blood was now again beginning to flow freely. A tourniquet was applied over the femoral artery, which retarded the hemorrhage, but did not altogether check it. The nature of the injury was at once evident, and the necessary steps immediately taken for securing the posterior tibial artery. Introducing a long narrow bladed knife into the wound, the muscles were carefully divided above and below the seat of injury, down to the deep fascia, which was clearly seen on sponging away the coagulated blood, and into which a small opening had been made. The manner in which the injury had been sustained was doubtful. When it occurred, the old gentleman was riding a horse that plunged violently, and threw him with great force to the ground; his foot was fixed in the stirrups, and he was dragged some distance; he says, when his foot got at liberty, the horse kicked him with considerable violence on the leg; he had neither trousers nor gaiters upon his leg, which was only protected by a thick stocking. On looking at the shoes of the horse, it was found he had been shod behind with what are called "caulkings," one of which it is supposed had been driven into his leg. The opening in the fascia was enlarged, and, after removing a good deal of coagulated blood, the artery was found, and secured by passing a ligature above and below the wound, the vessel was divided between them. The wound in the muscles was then brought together, and a bandage applied from the toes to the upper part of the thigh; the patient appeared to experience much relief from this, which in a great measure checked the spasm and quivering of the muscles, which was somewhat severe during and immediately after the operation. A large dose of liq. opii. sed. was given. No constitutional disturbance worthy of notice took place. Both ligatures came away on the 12th day after the operation. Mr. Hall saw this gentleman some time afterwards; he was on horseback, and told him he could not discover that the leg on which the injury was sustained was worse than the other; and that it did its work very well.

Case 52.—A robust young man was admitted into the Middlesex Hospital on January 1, 1845, with a punctured wound from a joiner's chisel in the calf, at the junction of the upper with the middle third of the leg, and a little to the inner side of the mesial line. Arterial and venous blood flowed in quantity. From the situation, depth, and direction of the wound, as ascertained by a probe, it was evident that the posterior tibial was probably wounded. Mr. Arnott determined to cut down upon it at once, in order to secure both ends. For this purpose, taking the punctured wound as a centre, he made an incision through the skin and muscles of the calf, to the extent of six and a half inches; the deep fascia being thereby exposed, the opening in it made by the chisel was enlarged to the extent of two inches. After considerable difficulty from the bleeding, it was ascertained, that besides the wound in the posterior tibial, both venæ comites were divided. On account of the troublesome character of the bleeding from these veins, and the difficulty created in discovering the artery, one of the veins had a ligature placed on both ends, whilst the lower end of the other was subjected to pressure. Two ligatures were then placed on the artery, one above and the other below the puncture; it was not till the latter was tied that the hemorrhage ceased. Little

febrile disturbance followed the operation; the lower ligature on the artery came away on the eighth day, the upper on the ninth. During the night of the eleventh, some bleeding took place from the lower angle of the wound, which was not arrested by compression of the femoral artery, but which was easily checked by displacing some coagula from the wound, and making pressure at the lower part of it by means of a small compress of lint, which was left in the wound. This was removed in three days, and the case proceeded subsequently uninterruptedly to a favourable termination. The wound cicatrised in less than two months, and the patient recovered with a perfectly efficient limb.

Case 53.—John Sullivan, 27th regiment, had his leg amputated six inches below the knee, at Tarragona, in April, 1833, by Staff-surgeon Roche, in consequence of a compound fracture and dislocation of the ankle-joint. Three days afterwards hemorrhage took place, and a small aneurismal tumour about the size of a pigeon's egg was discovered bleeding about an inch above where the ligature had been applied. This part of the calf was laid open, and a ligature applied midway between the sac and the origin of the artery from the popliteal. It succeeded, and was the operation of Anel, justly preferred to that of Hunter, because there was an open stump with which the little aneurism was continuous.

Case 54.—Jean Debret, a French prisoner of war, came under the care of Staff-surgeon Collier, in the beginning of September, having been wounded at the battle of Waterloo by a musket ball, which broke both bones of the left leg, and required several incisions to be made into the soft parts, which were greatly implicated by disease. He had suffered an attack of erysipelas, and the constitution had sympathised greatly with the injury, and was little able to resist it. Towards the end of the month the wound assumed the character of the hospital sore or gangrene, which spread rapidly over all the parts down to the tibia. The extensor tendons were dissected bare for the space of four inches, and the interosseous membrane even appeared to have partaken of the disease. On the 4th of October hemorrhage took place about two inches and a half above the ankle-joint, which was arrested by pressure. On removing this and some coagula which covered the artery, it bled furiously; a little dissection laid the artery bare an inch and a half above this spot, where a ligature was passed around it, and the bleeding never returned. The ligature came away on the sixth day, and the man recovered, and was sent to France with a serviceable leg, although lame.

Several of our best anatomists, in order to avoid the operation I have recommended, which Messrs. Hall and Arnott have so well performed, and which renders the division of the great muscles in the calf of the leg necessary, advise a tedious and more difficult operation to secure either the posterior tibial or the peroneal artery; and as a mistake may be made as to which is divided, when the wounding instrument has passed from side to side, and blood flows freely from both orifices, they further advise that one should be tied first, and if not successful, that a second operation should be done to expose the other, instead of doing my operation at once, and thereby enabling the operator to place a ligature on either, or on both.

The operation of tying the posterior tibial artery in the middle of the leg, after the ordinary methods recommended, is not very easily accomplished. It is said the leg should be bent, the foot extended, and both placed on the outer side; an incision should then be made, about four inches in length, along the inner edge of the tibia, through the integuments and fascia (the internal saphena vein should be avoided), when the edge of the gastrocnemius muscle will be exposed, which may be easily raised and drawn to the outer side; a director should then be insinuated beneath the head of the soleus, on which this muscle must be divided from its attachment to the tibia; the deep fascia of the leg will then be seen very tense and strong, binding down the deep-seated muscles and the tibial nerve and vessels; this must be cautiously divided on the director passed beneath it. The foot should then be extended as much as possible, and the knee placed in the flexed position, to relax the superficial muscles on the back part of the leg, when the artery may be felt pulsating about an inch from the edge of the tibia; the veins are then to be separated from the artery with a blunt instrument, and the aneurism needle passed round the latter in a direction from without inwards, so as to avoid the posterior tibial nerve.

On the dead subject this operation is not attended with much difficulty; in the living however the case is very different: the muscles are then rigid and unyielding, and when the fascia which covers them is divided, they leave their natural situation and become much elevated, so as to make the situation of the artery appear as a deep cavity, at the bottom of which the vessel is placed. Add to this that the artery is cut across, has retracted upwards and downwards, that both ends may not bleed and cannot be found in the small space which has been made, although both require to be tied; add to this that the surgeon may have made a mistake, and finds that it was the other and more distant artery that is wounded, or that both are injured, and the operator will be in a very unenviable condition.

Let us proceed however with the simple case. The operator has cut his four inches, has turned up the edge of the gastrocnemius, and has insinuated his director under the head of the soleus, which he has also sliced away from the bone. The artery is still an inch inwards, bound down by a strong fascia; pulsating it is said, bleeding I say if it pulsates, all this time as fast as it can, or else a tourniquet has been applied, and the pulsation has been suspended. The fascia must be cut immediately over or by the side of the artery; it will not do to separate it from the bone, and then push it over; it cannot be done, and would not do if it could. The artery must then be allowed to bleed. The

tourniquet must be unscrewed, and the wound is immediately filled with blood. Nothing can be done until this is sponged out, and to enable this to be done, the tourniquet must be screwed up, and then the surgeon is pretty much where he was before. We will suppose that he has succeeded in dividing the fascia, for an inch at least in extent, over the artery, without injuring it or anything else. What is directed to be done next? Why certain evolutions are to be performed with the leg, as described above, and then the surgeon is to separate the two veins from the artery with a blunt instrument, and then he is to pass an aneurismal needle under the artery from without inwards, so as to avoid the nerve. Now all this is to be done in a hole, the bottom of which the operator can scarcely see, and if he could it would not signify, because it is on the side of the bottom of the hole he is to perform these different evolutions on parts too likely to be covered continually with blood; for although the bleeding from the upper end of the artery may be suppressed by the tourniquet, that from the lower end in young persons may not; and at all events the unscrewing of the tourniquet will cause a most troublesome oozing, occupy a great deal of time, and give rise to much pain. Lastly, when the operator comes to the fascia, he will find his first four inches will not give him room enough; if he succeeds in dividing it, and tries to find the artery, the deficiency of space will cause him to enlarge his first incision; and before he has completed his operation, the quantity of cutting, retracting, pulling, sponging, and bleeding will make it to himself a most unsatisfactory operation. Of the patient's sufferings we will say nothing. If a bystander should inquire, why this most painful, difficult, bloody, tedious, and dangerous operation (dangerous from the chance of failure) is done?—the answer would be, solely because it is not usual to make a longitudinal incision in the muscles of the calf of the leg; an incision which if made by accident would be pronounced to be one attended with little danger, and not likely to lead to any subsequent detriment. Let us compare this operose proceeding with the following simple operation:—

An incision is to be made six or seven inches in length, by successive and rapid incisions, through the integuments and muscles of the calf of the leg down to the fascia. The centre of the incision is to be on a line with the holes made by the wounding instruments, or if they are diagonal to each other, between them; and it may be either directly in the middle of the calf, or a little to the side of, or directly over the artery supposed to be wounded: it is not material which. The smoothness of the fascia points it out, and the loose cellular membrane connecting the divided muscles to it, allows of the edges of the long incision being easily separated, and to such a distance as to admit of the exposure not only of the posterior tibial artery, its two veins, and the nerve, in as distinct a manner as any other arteries, veins, and nerves, can be exposed in the human body, but of the peroneal artery also. The tourniquet is then to be unscrewed, and the bleeding, if the wound did not bleed before, leads to the spot where the artery is injured. The artery may be laid bare in its whole extent by as common a piece of dissection as any ever practised, and nothing can interrupt the application of the ligature to either or both vessels, if they should be wounded. The nerve, the veins, and the fascia cease to be surgical bugbears, and the operation is as simple as any in surgery. No surgeon or anatomist can dispute this statement. Mr. Hamilton, M. Berard, and others, have also successfully treated wounds in the lower part of the posterior tibial artery in this way, and a careful consideration of the cases related, and the facts and arguments advanced, must, I am satisfied, cause every surgeon to conclude that there is only one right way of treating wounded arteries in the leg.

My kind friend, Mr. Carmichael, of Dublin, at the conclusion of his case No. 39, reproaches me with having said, "In all cases of aneurism of the gluteal and sciatic arteries, the internal iliac should be tied, instead of an operation on the part itself." He admits he is aware that I do not mean this sentence to apply to aneurismal tumours, the consequence of wounds, but only to aneurisms formed after injury of the artery. It was however, he says, quoted against him as an authority in his case which I have transcribed, and he is therefore desirous that all ambiguity on this point should be removed, that I should on all future occasions explicitly declare that all wounded arteries, and all aneurismal swellings of recent date occurring after wounds of arteries, are to be treated by ligatures of the artery at the wounded part. He desires that I should do this in such manner as to remove all doubt on the subject. I now comply with this desire in the plainest possible manner, and declare that any other mode of proceeding is contrary to those principles which ought to guide the surgeon not only in all such cases, but in all others in which it can by any possibility be applied.

LECTURE IV.

Wounds and injuries of the axillary artery; Results of ligature of the subclavian artery; Great fatality of the operation; Mr. Keate's case of ligature of the subclavian, below the clavicle, for axillary aneurism, following a gun-shot wound; Mr. Chamberlaine's case of ligature of the subclavian, below the clavicle, for axillary aneurism, the result of a wound from a cutlass; Case of immediately fatal wound of the axillary artery from a musket-ball; Case of sabre-cut, dividing the pectoral muscle; Case of wound of the axillary artery, and ligature of the injured vessel; Delpech's case of wound and ligature of the brachial artery, followed by secondary hemorrhage from the irritation caused by the ligature d'attente*; ligature of the axillary or subclavian, suppuration under the pectoralis major, and death; M. Galtié's case of ligature of the subclavian above the clavicle, for secondary hemorrhage after amputation at the shoulder-joint; Treatment of hospital gangrene by the actual and potential cautery; Larrey's case of presumed wound of the subclavian artery and vein; recovery without operation; Delpech's case of wound of the carotid; recovery without operation; Elasticity and resistance of arteries to injuries; Larrey's case of sword-wound of the ulnar artery, cured by compression; formation of an aneurism; ligature of the brachial, opening of the aneurismal sac, and ligature of the interosseous artery; Cutanoso's case of wound of the axillary artery; ligature of the subclavian below the clavicle; extensive suppuration; enlargement of the wound, and treatment by compression; Montanini's case of ligature of the axillary for false aneurism caused by a wound; Dupuytren's case of ligature of the subclavian, above the clavicle, for an aneurism of the axillary artery following a wound; Lallemand's case of ligature of the subclavian, above the clavicle, for diffused aneurism of the axillary artery following a wound of that vessel; extensive suppuration of the sac; Professor Blasius' case of wound of the arm-pit by a sword; ligature of the subclavian, terminating fatally; Dr. Monteath's case of ligature of the axillary artery for diffused aneurism, the result of an injury; Messrs. Maunoir's case of ligature of the wounded axillary artery; Desault's case of ligature of the wounded axillary artery; Dr. Scgond's case of ligature of the subclavian above the clavicle for a wound of the axillary artery; Dr. Nott's case of ligature of the subclavian, above the clavicle, for secondary hemorrhage following sloughing in the axilla; Mr. White's case of ligature of the subclavian above the clavicle, for a circumscribed aneurism of the axillary artery following a wound of that vessel; Dr. Buchanan's case of ligature of the right subclavian for secondary hemorrhage from the brachial artery; Dr. Gibson's case of ligature of the subclavian, above the clavicle, for an aneurism in the axilla, from external injury without a wound; Dr. Warren's case of ligature of the subclavian, above the clavicle, for rupture of the axillary artery from violence; Injury of arteries from cannon-shot; Mr. Stanley's case of rupture of the inner and middle coats of the brachial artery from external violence; Sir C. Bell's case of lacerated wound of the axillary artery from machinery; Dr. Post's case of ligature of the subclavian, above the clavicle, for secondary hemorrhage after amputation at the shoulder-joint; M. Haspel's case of ligature of the subclavian, below the clavicle, for a wound of the axillary artery; Question of amputation at the shoulder-joint in such cases; Case of wound of the brachial artery, cured by compression; M. Haspel's case of wound of the brachial artery, and ligature of both ends of that vessel at the seat of injury; Case of rupture of the axillary artery from external violence; formation of a diffused aneurism, followed by amputation at the shoulder-joint; Dr. Mackenzie's case of injury of the axillary artery from a wound with a red-hot poker, and ligature of the subclavian above the clavicle; Remarks on the practice of applying a ligature on the subclavian, above the clavicle, for wounds of the axillary artery; Remarks on the preceding cases; Case of amputation of the arm, followed by secondary hemorrhage, and ligature of the bleeding artery; Occlusion of an arterial branch immediately above or below a ligature placed on the main trunk; Secondary hemorrhage from ulceration of the arteries, in the sloughing state of stumps after amputation; Ligature of the main arterial trunk; Secondary amputation; Treatment of secondary hemorrhage after amputation of the thigh; Treatment of secondary hemorrhage after amputation at the shoulder-joint; Secondary hemorrhage with retraction of the soft parts after amputation, and formation of a conical stump; Opinions of French surgeons on secondary hemorrhage, consecutive to local inflammation, ulceration, or sloughing; Condition of arteries in inflamed parts; Mr. Stanley's case of wound of a branch of the epigastric in the*

operation for femoral hernia; Case of wound of a branch of the external pudic artery, during the operation for castration; Wounds of the circumflex arteries during amputation at the shoulder-joint; Anatomical description of the axillary artery; The operation for applying a ligature on it; Mr. Quain's case of supposed wound of the axillary artery.

The axillary artery has not fared better in many instances, than the posterior tibial, and peroneal arteries. The same dread of dividing muscular fibres has overcome all other considerations, and instead of placing two ligatures on the part of the vessel actually injured, one above, the other below the wound, the subclavian artery has been tied at a distance from the injury, sometimes below, sometimes above the clavicle, oftentimes to the destruction of the patient, and even when successful, in defiance of the theory on which such proceeding is founded.

Dr. Norris, of Pennsylvania, has collected and published, in the 10th vol. of the *American Journal of the Medical Sciences*, for 1845, the results of sixty-nine operations performed on the subclavian artery, either above or below the clavicle. Of the sixty-nine cases, thirty-six recovered, and thirty-three died. This may be considered as one and one—a result that should cause every surgeon to pause and think again and again before he resorts to an operation, if it can by any possibility be avoided, which may be considered so deadly as to fail in thirty-three cases out of sixty-nine. It is his duty to satisfy his mind on running such a risk, that no other operation is likely to be less fatal.

Of the sixty-nine cases, seventeen were done in consequence of wounds of the axillary artery, and of these nine recovered, seven died, and one failed to arrest the bleeding, which was only effected by amputating the arm at the shoulder-joint; eight failures against nine recoveries; eight out of seventeen is in the proportion of thirty-two against thirty-six, the average of the whole sixty-nine being thirty-three against thirty-six.

In the seventeen cases collected by Dr. Norris, the operations were done by Messrs. Chamberlaine, Baroni, Galtié, Gibson, Buchanan, Lallemand, Segond, Blasius, Haspel, Catanoso, Montanini, Syme, White, Nott, Hutin, McDougal, and Mott. M. Berard says that in twelve cases he is acquainted with, three only were successful, but this is certainly more than the average mortality.

The object of these remarks is to show that the operation on the subclavian artery is always a fearful one, and the deaths do not seem to depend on the soundness or unsoundness of the artery itself; the mortality being equally great in cases of wounded, as of diseased axillary arteries. It may therefore be safely concluded that the danger lies in the operation, and that it should not be performed when another can be substituted for it, unless that other can be shown to be equally dangerous, when the selection becomes a matter of chance, as far as the life of the patient depends. The operation on the axillary artery itself at the part injured, in all cases of wounds, and in all cases of recent circumscribed or diffused aneurismal swellings, the consequence of wounds, is the substitute which ought in all cases to supersede it. It is an operation founded on principle, which the other is not, and which I affirm and believe will be found infinitely less deadly.

Case 55.—The first instance on record of the subclavian artery being included in a ligature, is that in which the late Mr. Keate, surgeon-general to the forces, applied it below the clavicle, in the York Hospital, Chelsea, in a case of axillary aneurism formed after a gunshot wound, of some months' standing, which had burst. Mr. Keate, after dividing the pectoral muscle in the course of its fibres, dipped down twice with a needle and thread, and the second time secured the artery. I was present at the operation, and assisted the late Mr. Carpue in taking care of the man afterwards, who recovered. I was too young to know any thing about the matter, and too much in awe of the surgeon-general to suppose for a moment that any thing he did was wrong. I have however often since thought of the two dips of his needle, and have even ventured to think that the patient was as fortunate in his escape from his doctor as from his disease.

Case 56.—Mr. Chamberlaine, of Jamaica, placed a ligature on the artery below the clavicle, in 1814, on account of an aneurism which had formed in the axilla, in consequence of a wound received from the point of a cutlass, which bled profusely, and healed in three days, leaving a scarcely perceptible cicatrix. The tumour was as large as an orange; the pulsation very strong; the pain from pressure on the nerves very distressing; there was no œdema of the arm; no elevation of the clavicle. The pulsation in the radial artery was not so firm as in that of the other side, and, before the operation, was becoming indistinct. The integuments over and above the aneurism were perfectly healthy in appearance. On the 17th of January, eighteen weeks and three days after the accident, a ligature was applied below the clavicle, in the first part of the course of the artery, and the patient recovered.

Remarks.—This was the operation of Anel done below the clavicle, and as the complaint was of eighteen weeks' standing, circumscribed, and with little pulsation in the radial artery, the operation was admissible, especially because an aneurismal sac had formed. I am, however, of opinion that if twenty patients were so operated on, and in twenty more the sac were laid open, and the artery secured above and below the wound, that more would escape with life and limb by the latter than by the former operation.

Case 57.—A soldier was wounded on the heights of Oporto by a musket-ball, which passed through the pectoral muscle, in the direction of the axillary artery, and went out behind. I saw him just as he expired from loss of blood, and immediately divided the pectoral muscle to see what

injury had been done to the artery. The ball had cut it nearly half across, it could neither contract nor retract, and the man had bled to death. If I had been in time to stop the bleeding, and had tied the subclavian artery, above or below the clavicle, the bleeding would have returned, and the man would have been lost, as the wounds of the integuments could not unite, so as to allow of the formation of a spurious circumscribed swelling. The artery could have been secured at the spot wounded with the greatest ease.

Case 58.—A French soldier at Salamanca received a sabre cut vertically and directly across the pectoral muscle, opening into the axilla, and exposing the vessels and nerves. He was afterwards ridden over and taken prisoner by the heavy German cavalry. The wound was always considered a simple one, and healed without difficulty.

Case 59.—A French soldier, at the battle of Salamanca, received a shot through his chest, and another through the axilla, which bled at the end of several days. I divided the pectoral muscle, and placed two ligatures on the cut artery above the origin of the subscapularis. The hemorrhage was suppressed, but the man died of the injury to the chest.

Case 60.—Delpech, in the case of a soldier who had been wounded in the south of France, in 1814, tied the brachial artery, as dissection afterwards proved, two inches below the subscapular branch, by an incision carried high up into the arm-pit; and according to the opinions of that day in France, he introduced a ligature under the artery an inch higher up, but which he left loose ready to tighten when necessary. On the ninth day afterwards, bleeding took place, and, to his great surprise, he found on trying to tighten the loose ligature that it came through the parts, and had been the cause of ulceration of the artery and of the bleeding. He immediately made an incision two inches and a-half long through the integuments into the wound, in a line between the pectoral and deltoid muscles; having then exposed the pectoralis minor, he divided it near its insertion into the coracoid process of the scapula. The axillary or subclavian artery was then seen, and tied, as it is about to pass between the two roots of the median nerve. This operation was so far successful; matter formed however under the great pectoral muscle and neighbouring parts, and the patient sank on the tenth day under his sufferings.

Remarks.—If Delpech had cut through the pectoralis major muscle, he would have left me nothing to suggest, and would have given such free vent to the matter formed under it, and in the axilla, that his patient would, in all probability, have been spared the irritation which caused his death.

Case 61.—M. Galtié, Delpech's assistant in the Hospital St. Eloi, at Montpellier, tied the subclavian artery above the clavicle, in consequence of hemorrhage taking place from the stump after amputation at the shoulder-joint. The patient died on the third day, exhausted. The opening in the artery was between the ligature on the stump and that on the subclavian, and had been occasioned, it was supposed, by hospital gangrene.

Remarks. — M. Galtié would have given his patient a better chance for life, if he had divided the pectoral muscle, looked the opening in the artery fairly in the face, placed a ligature above and below the wound, and then cauterised all the parts affected by hospital gangrene with a red-hot iron.

When the British wounded had left Toulouse, I visited Montpelier, and was received by M. Delpech, and the physicians and surgeons of the university, and of the Hospital St. Eloi, with the greatest courtesy. Delpech was then in the habit of cauterising all the cases of hospital gangrene with irons at a white heat, with the greatest success. I mentioned to him that we had gained similar good effects from the potential as he had obtained from the actual cautery, and especially from the use of arsenic, potassa fusa and the mineral acids in all cases of hospital gangrene and sloughing ulcers. Delpech, in his work on Hospital Gangrene, mentions this fact, and although I do not desire to be considered as the proposer of destructive measures for the cure of sloughing ulcers, I may without impropriety, claim to be the proposer or person who first recommended the use of the nitric and muriatic acids in such complaints. They were used liberally and effectively at Brussels and at Antwerp, and are after all, with the red-hot iron the remedies to be principally depended upon in this complaint, pure or diluted as the exigencies of the case may require.

Hospital gangrene often gave rise to hemorrhage, which led in the Peninsula to securing the vessels, sometimes near, sometimes at a distance from the part affected. I have tied the external iliac, the femoral, popliteal, humeral, radial, ulnar, posterior, and anterior tibial arteries, in consequence of their being opened by this disease. Most of these cases were lost, from the extension of the gangrene to the wound made by the operation, until the local destructive measures alluded to were adopted to arrest its progress. The last case on which I operated at Santander, after the battle of Vitoria, succeeded. It was on the anterior tibial artery.

On my way to England I visited Paris. The Baron Larrey received me with open arms, and took me to his hospital at the Invalides. There he heated his irons, and applied them very vigorously to a large ill-conditioned ulcer on the right hip of a French soldier, who could not refrain from a howl that would have done honour to any gentleman whatsoever. The Baron stopped for a moment, looked in the man's face, and said, "Vous êtes de la garde," and then proceeded with his irons. The soldier uttered not another word.

Case 62.—Pierre Cadrieux, aged thirty-two, received a wound, in November, 1811, from the point of a sword, which passed in a direction backwards, downwards, and outwards, from immediately above the clavicle, dividing the outer part of the sterno-cleido-mastoideus muscle, and of the scalenus anticus

muscle, and opening into or cutting across, as was presumed, the subclavian artery and vein, as they are becoming axillary or passing over the first rib. The bleeding was terrific, and the man fainted and remained as if dead. A compress was applied, and he was brought to the Hospital of Gros Caillou, and placed under the care of Baron Larrey. The next morning he looked like death, and could hardly speak; the wound, which was somewhat more than half an inch long, did not bleed; a swelling had formed above and below the clavicle, pulsating more strongly above. A peculiar thrilling sound could be felt and heard deeply in the direction of the axillary vein; the arm was cold, insensible, and without pulsation in any of its arteries, not even the axillary. The wound was treated by compress and bandage, the arm with warm camphorated fomentations; the patient being supported by wine and good soup, gradually recovered, and as some excitement followed, the next day he was bled, and cold was applied to the swelling. Under this careful treatment the wound healed on the eighth day, and the patient gained strength and gradually recovered the use of the arm. On the twentieth day, the aneurismal swelling had disappeared, but the thrill remained, with the pulsations of the vein of the neck, which pulsation never became perceptible in the arm. On the fifty-fifth day some slight pulsations could be felt in the arteries of the arm, and the thrill in the vein had diminished. In 1815 the Baron again saw P. Cadrieux, and found to his astonishment that no pulsation could be distinguished in the axillary, radial, or ulnar artery. A change had taken place in the circulation of the limb, which preserved nevertheless, its warmth and sensibility, although the fingers were drawn forcibly into the hand, from the brachial plexus of nerves having been also injured.

Case 63.—Delpech, in a nearly similar case of wound, in which he believed the common carotid was wounded near its origin, and which was followed by a terrific hemorrhage which almost destroyed the patient, acted in a similar manner, and with the same successful result.

Remarks.—These two cases show the propriety of that rule I have endeavoured to establish of letting large arteries alone until they bleed and demand attention. There can be little doubt that if Larrey and Delpech had tried to perform operations on these arteries, they would have lost their patients. It is time enough to put men's lives in jeopardy when the necessity for doing something is manifest. Formidable operations are not to be done on the speculation that they may be required, and this should never be forgotten, for there are several cases on record in which the main trunk of a limb has been supposed to be divided, when, in fact, trifling branches only have been injured.

An artery possesses an elastic and resisting power which enables it to yield in a great degree to an opposing force without being torn, and to suffer a degree of contusion which would lead to sloughing in other parts with little comparative injury.

I published the case of Captain Flack in my work on Gunshot Wounds, page 330, in which several inches of the femoral artery were laid bare by a cannon shot, and were seen for three weeks pulsating in the usual manner, until gradually covered over by granulations. In this case the artery maintained its life and functions unimpaired.

At the battle of Albuhera, Captain Gibbons, of the fusiliers, was wounded by a musket ball, which entered immediately below the clavicle, and passed out behind, so directly in the situation of the axillary artery, that it was supposed it must be injured. Great inflammation followed in the chest, and his life was saved with difficulty. He died of phthisis in 1829; and on examining him particularly, I found that the artery was obliterated at the part where the ball had passed by the side of it. I have seen, however, many instances in which no such event followed. The late General Sir Lowry Cole, was wounded when advancing with the 4th division of infantry to attack the French centre at the battle of Salamanca. The ball passed under the clavicle, injured the first rib close to the artery, and passed out behind, without implicating the artery or giving rise to any inconvenience, further than a diminution of the force and size of the artery at the wrist when compared with the other. At the first siege of Badajos, two officers of the 40th regiment met with injuries nearly similar; and I have seen the subclavian artery as well as the carotid fairly divided; but then death immediately ensued. The fact of arteries yielding a passage to a ball, and recovering themselves and their situation without rupture or sloughing, is well shown in case No. 24, of Turnbull, and is I believe sufficiently established to require no further confirmation.

Case 64.—L. B., twenty years of age. In Sept., 1811, was wounded by the point of a sword in the right arm, which opened the ulnar artery. The bleeding was arrested by compression, and the wound healed in twenty days. Shortly afterwards a small tumour of an ovoid form appeared under the cicatrix of the wound, which, in the course of a few months, attained the size of a man's first. Larrey tied the brachial artery in the arm above the tumour, and afterwards laid open the aneurismal sac, which was full of layers of fibrous coagula he had some difficulty in detaching; he then sought for the upper and lower ends of the artery, which he thought had been divided and separated by the sword; this had not however happened, but the artery at the wounded part had become dilated, the portion immediately above being funnel-shaped or dilated in that form, the lower end being on the other hand, obliterated; between these two points the interosseous artery entered the sac, and bled so freely as to require a ligature being passed around it underneath the sac. The ligature on the brachial artery came away on the ninth day, that on the interosseous artery on the eleventh, and the patient was cured in six weeks.

Remarks.—If the Baron had been contented with his first ligature, his patient would have been well

in half the time, and with less than half the suffering. By opening the sac he placed an aneurism of some months' standing in the state of a wounded artery, and had to tie a vessel with a good deal of difficulty, which never should have been exposed.

Case 65.—Catanoso, of Messina, in September, 1835, was called to a man with a wound in the arm-pit, which oozed blood frequently until the fourteenth day, when an alarming hemorrhage caused him to place a ligature on the artery, below the clavicle, which he found it very difficult to do. The wound did not heal by the first intention, but suppurated, and discharged a quantity of sanious and offensive pus mingled with coagulated blood. It was therefore enlarged to give free vent to the discharge. On the nineteenth day after the operation, arterial hemorrhage took place. The clots being removed, the hollow whence the blood proceeded was filled with resin, charcoal, and gum arabic, retained by compresses and a tight bandage. The hemorrhage did not return, but the cure took some months to complete.

Remarks.—If the operator had divided the anterior fold of the arm-pit by a vertical incision, and placed one ligature above and another below the wound in the artery, his patient would not have had in all probability secondary hemorrhage, and would have been cured in half the time, and with much less risk.

Case 66.—Montanini, of Naples, tied the axillary artery below the clavicle, sixteen days after the accident, in a case of wound which healed early, and allowed an aneurismal tumour to form, the size of the fist. Six days afterwards the tumour burst, and about five ounces of coagula were discharged. The sac suppurated, but no bleeding took place. An abscess formed under the pectoral muscle, requiring to be opened. The patient was cured in thirty-six days.

Remarks.—The inflammation of the sac which led to its rupture on the sixth day, closed the axillary artery below in all probability, or the patient would have bled to death, unless another operation had been performed to tie it also.

Case 67.—C. Chevalier, aged thirty-seven, was wounded, in 1811, in Spain, by a thrust with a sword on the back of the shoulder, which caused him to faint after a great loss of blood. The wound healed in three weeks. Two months afterwards he perceived a small tumour in the axilla, about the size of a nut, and pulsating. Two years afterwards it was as large as a hen's egg, and after some laborious exertions it rapidly attained the size of a child's head. M. Dupuytren tied the artery above the clavicle, between the two scaleni muscles, the anterior of which was divided; the man escaped, and at the end of several months resumed his occupation of a joiner, and enjoyed good health for three years. The tumour did not entirely disappear, for after a great exertion, inflammation and pain came on in the axilla, and he applied at the Hotel Dieu again in 1822. At the end of a fortnight it suppurated, burst, and discharged a large quantity of matter, having the colour and consistence of pounded raisins. The opening was enlarged, the sac injected, and he left the hospital, cured, in three months.

Remarks.—This was an aneurism formed after the manner supposed in cases 55 and 56. Being of long standing, the ligature of the subclavian above the clavicle was admissible, but there can be no doubt that this man would have run less risk, if the sac had been laid open when of the size of a hen's egg.

Case 68.—Lallemand of Montpellier (*Archives Générales de Medecine*, vol. vii.) was called to a young man who was wounded by the point of a sword through the middle of the anterior fold of the arm-pit, and lost a good deal of blood at the time; but as the small wound became obstructed, the blood only oozed out; a large effusion, however, took place into the arm-pit, and into the cellular membrane of the chest, arm, and neck. M. Lallemand with great difficulty tied the subclavian artery above the clavicle. On the twelfth day the ligature separated, but the diffused aneurismal tumour became larger and more painful; fluctuation being manifest, a puncture was made into it, and an enormous quantity of chocolate coloured matter was evacuated, together with many large black lumps of coagulated blood. The day after another swelling required another puncture, for the evacuation of a further quantity of fetid pus, with sloughing cellular membrane, &c. A third abscess formed, and required another puncture, followed by similar results. A month after the operation the pulse returned in the radial artery, eight days after in the ulnar, and the patient ultimately recovered.

Remarks.—If an incision had been made at first, through the anterior fold of the arm-pit, the coagulated blood would have been readily evacuated, the wounded artery would have been tied, and the patient cured without difficulty. If the collateral circulation had been early established, this operation would have been necessary to stop the bleeding which would have taken place. This man had a lucky escape from his accident and his operation.

Case 69.—It is stated in vol. xxx of the *Med. Chir. Review* that a young man was brought to Professor Blasius, of Hallé, with a wound through the posterior fold of the arm-pit from a sword; he bled profusely and on several occasions. On the twentieth day after the accident, Professor Blasius tied the subclavian below the clavicle, and the patient died from exhaustion two days after. On dissection the axillary artery and vein were found uninjured; the bleeding had taken place from the circumflexa humeri posterior and circumflexa scapulæ arteries. Dr. Blasius condemned in severe terms the negligence of not laying bare the artery or arteries wounded, and applying a ligature to them, instead of upon the main trunk, which was unhurt.

Remarks.—It is plain that if these arteries are of any use in the collateral circulation, bleeding must be renewed by them, after the subclavian has been tied above their origin, unless they should be

accidentally closed in the interval. I need not add to the forcible criticism of Blasius, which is unanswerable. In this, as well as in Case 67, the posterior fold of the arm-pit might have required to be divided instead of the anterior.

Case 70.—Dr. Monteath, of Glasgow, was called to a gentleman on the 20th of September, 1813, whose right arm had been run over by a heavy coach, about its middle, and bruised from the shoulder to the wrist without lacerating the skin. Great inflammation ensued, followed by suppuration, the matter being evacuated by an incision over the biceps muscle, twelve days after the accident. This was followed by great sloughing of the integuments, and on the twentieth day by hemorrhage inducing syncope. Hemorrhage again took place, and some operation to arrest it was necessary. The gangrene had extended close to the boundaries of the axilla, and the axillary artery was, therefore, secured by ligature as high up as it could be got at by an incision at the arm-pit, under the anterior fold made by the pectoral muscle, and, as Dr. Monteath believes, above the origin of the subscapularis and circumflex arteries. The patient recovered with an arm, after a time, "in all respects perfect."

The Messrs. Maunoir of Geneva, performed nearly a similar operation, after a sword-wound, with success. Desault, Langenbeck, and Roux, have each recommended the division of the pectoral muscle for this purpose, and if Desault had been better acquainted with the management of the ligature, success would have attended his efforts, and he would have left me nothing to propose, but to follow the example he set in 1795, in the following case.

Case 71.—The point of a sword passed through the pectoral muscle, an inch above its lower edge; a great quantity of blood was lost, and a large swelling formed in the axilla, between the folds of the arm-pit. Seven days afterwards the man was admitted into the Hotel Dieu. An incision was made in the course of the axillary artery, commencing below the clavicle. The two lower thirds of the pectoral muscle were divided, and the coagulated blood removed from the axilla, so as to expose the artery, veins, and nerves. So far the proceeding of Desault was to be applauded. He then included all the vessels and nerves in one mass by a temporary ligature. The artery was then separated, and tied separately immediately above the origin of the circumflex and subscapular arteries. The temporary ligature was then loosened, but was not removed. No more ligatures were then applied below the wound in the artery. The man died six days afterwards of mortification.

Remarks.—If in this case Desault had placed two ligatures on the artery, one above and the other below the wound in it, instead of four, without fear of being unable to command the bleeding, his patient would, in all probability, have recovered.

Case 72.—Dr. Segond, in French Guiana, in April, 1834, was called to a wound of the axillary artery in a negress, which took place by a fall in February. The fourth or fifth day after the accident she lost a great quantity of blood; at the end of a month she seemed nearly well, with the exception of a small abscess, from which a little bloody discharge took place, and in which an aneurismal tumour had formed. The subclavian above the clavicle was tied, and the patient recovered very fortunately.

Case 73.—Dr. Nott, of Alabama, U. S., was sent for to C. Clausel, aged thirty, shot through the wrist and axilla by small shot on the 27th of August. The wrist was amputated. A slough formed in the axilla. On the twelfth day hemorrhage took place to the extent of two pints, returned on the thirteenth, and again on the sixteenth; it was arrested by compression. On the eighteenth day the slough separated, leaving a large cavity in which the artery could not be felt. By the middle of October the cavity had filled up, and the ulcer had nearly healed, when an aneurismal tumour began to form and gradually extended up to the clavicle. On the 29th of November a ligature was placed on the artery above the clavicle. On the thirty-first day this came away, having been so tightly tied that an ordinary sized pea could hardly be passed through the noose after it came away. On the fortieth the wound had healed, but the pulsation which had returned on the second day after the operation was still strong and the *purr* distinct. These had a little diminished in five months, and the patient was found to be cured two years afterwards.

Case 74.—Mr. White, of the U. S., tied the subclavian above the clavicle, in September, 1838, for a wound of the axillary artery, which had formed a circumscribed aneurism likely to burst. The operation succeeded.

Case 75.—Dr. Buchanan relates a case in the third volume of the *Glasgow Medical Journal*, in 1830, page 233, in which he tied the subclavian artery of the right side in consequence of hemorrhage from the brachial artery, the result of the separation of mortified parts after a severe injury. The man died five days after the operation. The post-mortem report says, after the parts had been dissected, and the scalenus anticus muscle had been cut and turned aside, "the subclavian artery was well seen with the ligature firmly tied round it, and a hard clot of blood perceptible on its cardiac side. The clavicle was then removed, and the axillary artery traced under the pectoralis, onwards to its termination in the stump, during which transit it seemed quite healthy, till about an inch below the axilla, when it assumed a soft, greenish appearance, and no clot could be discovered on the distal side of the ligature. The muscles surrounding the shoulder joint were soft, green, and matted together, and a large collection of fetid pus extended from the slough below the axilla, to the under surface of the pectoralis major and minor, the whole substance of which last was in the same gangrenous state as the muscles of the shoulder-joint."

Remarks.—Dr. Buchanan justly attributes the immediate cause of death to mortification of the extremity, but he does not seem to consider that its continuance and extension were at least maintained and encouraged, if not rendered inevitably destructive, by his having cut off the supply of blood around the shoulder, by tying the subclavian artery above the clavicle. This he did, because he supposed the operation of tying the artery under the pectoralis major and minor to be an operation which had never been done, and says, "Further, I am of opinion it never ought to be had recourse to." This was Dr. Buchanan's error. The very simple operation of dividing the integuments and pectoralis major muscle from a little below the clavicle into the axilla would have exposed the artery, which it will be seen from the dissection report was quite healthy, even for an inch below the axilla. This incision was also necessary, if for the purpose only of giving a free vent to the matter collected under the pectorales major and minor, and around the shoulder-joint. It would have tended to arrest the sloughing process, and the arm, having the advantage of the collateral branches which were cut off by tying the subclavian, might not have been lost. It is possible the man might not have died.

I have stated that the principal trunk of an artery may be injured by internal and by external violence without any wound of the integuments, of which the following cases are examples :—

Case 76.—Dr. Gibson, of Pennsylvania, after reducing an old dislocation of the head of the humerus of ten weeks' standing, on 15th of March, 1828, which occupied one hour and a half, discovered the next day that an aneurismal tumour had formed in the axilla; and on the 17th he tied the subclavian artery above the clavicle; mortification of the hand and arm followed, and the man died on the 23rd. On dissection it was found that a small aneurismal sac had been ruptured, and which it was supposed might have existed from the period of the accident.

Case 77.—James A., aged about thirty, on the evening of December 23rd, 1843, while in a state of intoxication, slipped on ice, fell, and struck his left shoulder against the kerb-stone of the side walk. Violent efforts were made to reduce the dislocation, but in what manner the patient could not tell, excepting that he thought one person placed his foot with a boot on, in the axilla. He was sent to the hospital, and on the next day was seen by Dr. Warren, who found the left arm and shoulder much swollen. Leeches and cold applications were employed, and on the following day the swelling was so much reduced as to enable him to decide that no dislocation existed. During the night of the third day following (December 28th), the patient was seized with a violent fit of coughing, during which he felt something give way in his shoulder. The next morning the shoulder and arm were very much discoloured and enlarged; the arm was painful, and the patient much prostrated. On the 30th it was discovered that the man had no pulse in his left wrist, or in any part of the arm, and he had also lost both feeling and motion in the extremity. The swelling increased until it became enormous, the arm turning black in the axilla. A vesication was noticed on the back of the forearm. January 27th, 1844, an abscess was found to be forming in the axilla. In seven days it pointed, but did not open till February 4th, when it discharged a coagulum, and about a pint of fluid dark-coloured blood. Three days subsequently, at six o'clock in the morning, a sudden gush took place from the wound, by which the bed was inundated, the mattresses soaked, and the blood poured upon the floor. Exhausted and almost lifeless, he sunk into a state of syncope, and the hemorrhage ceased. As he was too low to undergo any operation, it was agreed that if he lived till the next day, the subclavian should, if possible, be tied. By the next morning, he had much revived. At ten o'clock he took eighty drops of the tincture of opium, and at eleven was carried into the operating theatre.

A great difficulty presented itself in the outset of the operation, the swelling of the shoulder, the tumour in the axilla, and the natural shortness of the neck almost obliterating the space between the shoulder and lower jaw. Dr. Warren, after minutely detailing the steps of the operation, states that the aneurism-needle was passed under the first dorsal nerve, which was mistaken for the artery. The wound was too deep, too narrow, and consequently too dark, to permit the artery to be visible. The anterior scalenus was partially visible, and, passing the forefinger of the hand to the edge of this, a good portion of the muscle was divided by the probe-pointed bistoury, introduced upon the finger. The subclavian artery then became quite sensible to the touch, and slightly distinguishable by the eye. A long aneurism-needle was passed under the artery, and at this moment a slight whistling was heard, and the author was satisfied that some air had entered the thorax. The ligature was tied, and the wound closed.

The patient improved after the operation. On February 22nd, the thirteenth day, the ligature was removed. On the 29th, a stream of blood was seen to issue from the unclosed part of the wound; the blood lost amounted to about a pint, did not issue per saltum, and was of a venous colour. The hemorrhage was arrested by pressure. At the commencement of March, he had an attack of pneumonia, confined to the lower lobe of the left lung, and also a second attack about the 1st of May. By the 1st of October, the swelling had disappeared from the arm, and motion had returned in the shoulder-joint. The large excavation in the axilla was reduced to a fistulous tube. On February 4th, three hundred and sixty-one days after the operation, Dr. Warren was able, for the first time, to detect a distinct pulsation in the radial artery, and subsequently one of an indistinct character in the ulnar and brachial. The patient, June 15th, had nearly recovered. There were still fistulous openings in

the neck and axilla. Sensation and motion were slowly improving.

Dr. Warren remarks, that the cause of the rupture of the subclavian artery in this case is involved in some obscurity. The probability seems to be, that great violence was employed in the attempt to reduce the bone, and that the arteries and nerves were contused by strong pressure of the operator's boot, combined with the forcible extension of the arm. The vessel did not rupture immediately, because its coats were contused, and not torn asunder, but a separation of the contused parts took place, in consequence of the violent efforts of coughing, on the fifth day after the accident.

Remarks.—I have had the pleasure of making the acquaintance of Drs. Gibson and Warren, of whose private character and professional attainments it is impossible for me to think too highly. They are universally acknowledged. I am therefore the more willing to express my dissent from the principle on which they acted in these instances. In Dr. Gibson's case the mortification which ensued after the operation might not have occurred if the aneurismal tumour had been opened, and the artery had been secured above and below the part injured; for I consider the mischief to have arisen from an injury, and not from disease of the artery. If Dr. Warren had cut across the integuments and the pectoral muscle in his case, and laid open the tumour in the whole of its extent, he would have been able to see the torn or even ulcerated part of the artery whence the bleeding came; for as the vessel was injured by the heel of the boot of the person who reduced the dislocation, provided there had been one, the artery must have been injured in the third or last part of its course before it becomes humeral, and the patient would in all probability have been perfectly well in two months, even if it should have been subsequently necessary to have placed a ligature on the lower end of the divided vessel, that is, the upper end of the humeral artery. The man nearly lost his life on the 29th of February from hemorrhage of a venous character, caused by the operation on the subclavian artery, which danger need not have been incurred, and he ran the risk the whole time of an arterial bleeding being renewed from the cavity in the axilla. When it shall be shown that the operation of dividing the pectoral muscle, and of tying the axillary artery at, under, or above the pectoralis minor muscle is more dangerous than tying the subclavian artery above the clavicle, I will yield my opinion that the subclavian artery should not be tied above the clavicle; but in the meantime, I may be permitted, without any great presumption, to say that this operation will be found to be at least three times more deadly in its average result than the other.

When a cannon shot strikes a limb, and bruises it most severely, without carrying away any part, constituting a sort of injury which I have explained, page 128 of my work on Gunshot Wounds, the great artery or arteries may be ruptured, not only in one spot, but the internal coat may be injured in several. I have given an account of one particular case, in which on dissection it was found that the posterior tibial and fibular arteries were torn across, and the popliteal artery, two inches higher up was closed by coagulable lymph thrown out from a rupture of the internal coat of the artery at this part. The limb mortified. These cases are supposed erroneously to have occurred from the wind of a cannon ball.

Case 78.—A boy, twelve years of age, had a waggon wheel pass over his arm and thigh. In the thigh there was a compound fracture. In the arm there were no other outward marks of injury than two or three small wounds, penetrating only the skin; but the arm throughout was cold and pulseless. In the axilla the pulsations of the artery could be felt, but nowhere below it. On the morning after the occurrence of the injury, the boy became delirious, and in the evening of this day he died.

Mr. Stanley on examining the arm found the biceps torn across its middle, and in the same situation the trunks of the vessels and nerves were all separated from each other by the laceration of their connecting cellular tissue. The brachial artery, for about two inches of its extent, appeared to be remarkably small, and on slitting it open, its inner and middle coats in the middle of the arm were found to be completely divided, the outer coat being entire. For nearly two inches above the laceration of the inner and middle coats, the canal of the artery was extremely contracted, and filled by a slender solid coagulum.

Mr. Arnott has noticed a nearly similar degree of mischief as occurring after the passage of a wheel over the limb, and this accident has been observed by others, and particularly by Mr. Turner, in the Transactions of the Medico-Chirurgical Society of Edinburgh.

Wounds of the axillary artery have been treated not only by ligature of the subclavian artery, but also by amputation of the extremity at the shoulder-joint—a mode of proceeding the expediency of which deserves consideration.

Case 79.—Sir C. Bell says in his Commentary on John Bell's Surgery, vol. i, p. 369, "a girl had her arm torn off near the shoulder by machinery. There was no bleeding, nor could the trunk of the artery be seen. As the arm had been almost fairly amputated by the machine, it was unnecessary to do more than make the edges of the wound even, and bring them together. As the axillary artery had not been tied, the patient was carefully watched. In the course of a few days hemorrhage did come on, and the surgeon very properly tied the artery below the clavicle. The bleeding from the stump immediately stopped, and everything went on well for several days; the stump became clean, and was granulating, when a second violent hemorrhage took place from it. The surgeon did not reach the hospital until the patient had lost a considerable quantity of blood. He immediately tore open the stump, which was already partly united, and then he saw

the blood issuing from the main artery. He secured it; but the patient sunk next day. On dissection, and by injecting the vessels, it was shown that the artery, where it had been tied below the clavicle, was obliterated, and that the blood had passed round by the supra-scapular branch of the inferior thyroid, from the portion of the subclavian artery above the ligature into the part below."

Remarks.—The surgeon in this case performed a very dangerous operation in a very admirable manner, and according to the principles he had been taught. Nevertheless, it was done contrary to every principle of good surgery, and, as far as I can see, for no other reason than for the purpose of avoiding a few fibres of the pectoral muscle.

In the first place, an operation, confessedly a very dangerous one, was done when it was in no way necessary, and which proved perfectly useless, a second requiring to be performed afterwards, of a very simple kind, and which was the one which ought to have been done at first, namely, searching for the bleeding end of the artery, and tying it. A life was here lost for want of a knowledge of principles. The operation failed, not for want of anatomical knowledge or dexterity, but from misapplication.

Case 80.—Dr. Post, of New York, was called to a ropemaker, who had divided the axillary artery becoming brachial, together with the veins and nerves, by a scythe. The ligature of the artery and the division of the vessels and nerves was followed by mortification of the arm, requiring the operation of amputation, which was performed two inches below the shoulder-joint. The artery which was found in a denuded state, being secured by a second ligature, placed three quarters of an inch above the one applied on the extremity of the artery in the stump. On the 30th of November, fourteen days after the operation, the patient was awakened by bleeding from the wound; the ligature having come away a day or two before, this was arrested, and there was no return of the bleeding until the 6th of December, when a profuse arterial hemorrhage took place, and the subclavian artery was tied above the clavicle. On the 9th of April he left the hospital, the wound over the clavicle, and the stump, the bone of which had exfoliated, being nearly healed.

Remarks.—This patient recovered, whilst No. 76 died of mortification and No. 79 of hemorrhage. The artery, in my opinion, ought to have been secured by an incision through the parts intervening above the vessel, and the ligature placed upon it below the edge of the pectoralis minor, where the artery would, in all probability, have been sound. It would then have been seen whether or not the subscapularis and circumflex arteries brought blood into the main trunk below this ligature, from their collateral connections, and required to be secured. If this operation, a very simple one in such a case, had failed, the greater one on the subclavian would have been a resource, and if that had not succeeded, the innominata need not have been spared, when the theory would have been carried out on the most *ultrâ* principles to that consummation which may be expected from it.

Case 81.—Bigneux, of the 1st battalion of artificers, was wounded in the arm pit in a duel, on the 4th February, 1835, at Metz, and suffered a considerable loss of blood. The anterior fold of the arm-pit was divided, and on examining the wound, a jet of blood, as large as the finger, darted from it. M. Haspel laid bare the subclavian artery by a separate operation below the clavicle, and secured it by ligature. The hand and forearm mortified; the limb was amputated; in a few days the man died. On dissection, a considerable effusion of blood which had formed into large clots was found in the cellular membrane at the back of the shoulder, and which M. Haspel supposes would have led to such irritation and suppuration, as might have placed the patient in great danger if he had survived. The ligature was found on the artery an inch and a half above the part where it was divided.

Remarks.—M. Haspel offers for the consideration of surgeons the question, whether it would not have been better to have amputated the arm at the shoulder in the first instance? I am of opinion that if he had enlarged the wound upwards, placed a ligature on the artery, immediately above where it was divided, and another in a similar manner on the lower end of it, this patient would have preserved his arm and his life. The clots of blood would have been discharged through the enlarged and dependant wound he had made, the patient being able in such cases to maintain an inclined if not an erect position for the greater part of each twenty-four hours.

Case 82.—M. Renneville, captain of cuirassiers, was wounded in a duel by a sword, which cut through the inside of the upper part of the arm, and gave rise to considerable hemorrhage, which was stopped by compression. The radial artery ceased to pulsate until the third day; the compression being continued in the course of the upper part of the artery, the wound healed, and the patient recovered, the brachial artery being obliterated for the space of about two inches. This case is a counterpart to No. 2.

Case 83.—Delahaie, sergeant 33rd infantry, was wounded by a sword, which divided the brachial artery at the upper part of the arm, close to the armpit. The artery was divided in the wound, together with the median nerve, and the lower end of the vessel was readily tied; the upper end had retracted, and could only be found after enlarging the upper part of the wound, when a ligature was applied, which came away on the twelfth day. The patient recovered.

Remarks.—M. Haspel, it would appear, had taken warning by what had happened in 1835, to Bigneux, and adopted a different course in 1839, a proceeding worthy of imitation, and highly to his honour.

Case 84.—On the 23rd of September Mr. A., twenty-three years of age, was thrown out of a gig

upon the road with great violence, and lighted on his left shoulder. It was at first thought that the humerus had been dislocated downwards; on more careful examination, it appeared that the bone was in its proper place, and that the hard tumour in the axilla depended on effusion of blood. The patient was kept quiet in bed, with cooling lotions applied to the injured part. For a day or two the swelling increased, extending down the arm, and the side of the body, and attended with discoloration of the skin. On the tenth day after the accident, a sensation of gushing was felt in the armpit, and the pain and tension suddenly became as great as ever. Leeches were applied, and the case again proceeded favourably for eight days, when another gush took place. Attacks of this kind then became more frequent, and at length occurred almost daily. They were always relieved by leeches, of which about three hundred had been applied. The arm was now enormously swelled by œdematous effusion, which extended to the points of the finger. A large fluctuating tumour occupied the axilla, and distended the pectoral muscle. There was no pulse at the wrist, and not the slightest movement or sound could be perceived in the swelling. The patient, worn out by pain, loss of blood, want of sleep, low diet, and apprehension, was reduced to a state of extreme weakness. In these circumstances it seemed difficult to determine whether there was an axillary aneurism or merely a bloody effusion. The gushing sensation, and absence of pulse at the wrist were in favour of the former view, while the complete absence of pulsation and aneurismal bruit in the tumour, from its commencement and during the whole period of its existence, could hardly be accounted for, except by the latter explanation. The case being thus doubtful, and as pressure had not been tried, it did not appear prudent to resort to any operation, until the effect of careful bandaging had been ascertained. A flannel roller was accordingly applied from the fingers to the shoulder and round the chest. He derived great comfort from the bandage: the swelling of the arm was considerably reduced, and there had been no return of the gushing sensation. He continued in this satisfactory state for three days, but on the morning of the 24th, severe pain was felt in the most prominent part of the swelling. This corresponded with the hollow of the axilla, and formed a round prominent tumour, of a dark-red colour, apparently about to break. An opening was made to the extent of half an inch, when a small clot of blood only was squeezed out, and a piece of lint was laid loosely upon the wound. Four hours afterwards the piece of lint was observed to be wet with arterial blood, a jet of which immediately followed. By means of a pin thrust through the lips of the wound, and a ligature tied round it, further hemorrhage was prevented for the time. The subclavian artery was now tied with a single silk ligature. The patient passed the remainder of the day tranquilly, and in the forenoon of the next seemed to be going on well. But at two o'clock, p. m., two or three ounces of blood escaped from the wound in the axilla, and a compress of lint was then secured over it by means of a spica bandage. At seven next morning, as the bleeding returned to somewhat larger extent, the surgeon stuffed the orifice with lint. At eleven, a. m., it was thought right to lay open the cavity, turn out all the clots that could be reached, and apply graduated compresses. When the artery was thus exposed it bled freely, but not with such force as to resist the pressure of the lint. In half an hour afterwards, however, the hemorrhage recurred, and as the temperature of the arm was then distinctly lower than natural, the only remaining resource seemed to be amputation at the shoulder-joint, which was done. The patient, for several hours after the operation, threatened to sink under this final act of his trials. He complained of nausea, and was deadly pale; his face was covered with cold perspiration; and his pulse could hardly be felt. Small quantities of wine were given to him frequently, and in the evening he revived, feeling warm and comparatively comfortable; the pulse became firm and could be counted—160. Next day it was 140; the day following, 120; and so on until it fell to the natural state. In other respects the improvement was equally progressive, and before the end of a week there was no room for anxiety, except on account of the ligature above the clavicle. It was longer in separating than usual, but probably lay loose for some time before it came away, owing to the patient's extreme aversion to let it be touched. His recovery was complete both in regard to the wound and the general health. The points in this case most deserving of attention are:—1. The way in which the artery was ruptured; 2. The absence of pulsation and aneurismal bruit in the tumour; 3. The inefficacy of tying the arterial trunk at a distance from the rupture, and with the intervention of branches; 4. The success of amputation in very desperate circumstances. Whether pulsation was prevented by the artery, being torn entirely across, and whether ligature of the subclavian would have proved effectual if not preceded by puncture of the tumour, are questions which the writer of the case leaves to the consideration of the reader.

Remarks.—This case gives support to the fact I believe to be sufficiently established, that the bruit, hiss, or aneurismal sound which may be heard by applying the ear to the part when an artery of size is wounded, is not always distinguishable through a quantity of blood which has been suddenly effused and has coagulated, whether from a wounded artery or from the rupture of an aneurismal sac, although it is distinct as long as the blood remains fluid. Pulsation is equally indistinct when the blood effused is coagulated, although the swelling may be elevated like any other tumour by the proximity of the artery, particularly if the main trunk is uninjured, and the blood has been poured out by a branch. The swelling was opened simply to prevent its bursting disadvantageously, and if the operator, on finding that arterial blood flowed in such quantity as to render further proceedings necessary, had laid

open the tumour in all its extent, as he was obliged to do two days afterwards, and had secured the artery above and below the wound in it, the patient would not have lost his arm, nor have run so much risk of his life, as the operation on the left subclavian artery always occasions.

Case 85.—Dr. Mackenzie was called, on the 5th of November, 1845, to a man who had fallen, with the whole of his weight, on a red-hot poker, the point of which entered the right axilla, immediately below the tendon of the pectoralis major, and seriously burned all the parts it touched. Eight days afterwards, a large eschar separated, followed by a copious flow of blood, which was arrested by pressure. The continuance of this by means of a graduated compress and bandage, evidently did mischief to the surrounding parts, and as the bleeding recurred, from time to time in spite of it, something more was clearly necessary. Three courses were, it was thought, open to the surgeon: one to cut through the pectoral muscle, and to place a ligature on the artery, above and below the part injured; the second to tie the subclavian artery above the clavicle, and if this should not succeed, in consequence of the collateral circulation re-establishing the hemorrhage, the arm was to be amputated at the shoulder-joint, under the advice of Mr. Syme as the third and last resource; because as Dr. Mackenzie says, "the vessel would probably have been divided in the incisions, above the injured point;" and the patient was in a state by no means unfavorable for the performance of such an operation. Again, the anastomosis existing between the branches of the axillary and subclavian arteries, rendered the propriety of trusting to a ligature of the latter vessel, as a means of arresting the hemorrhage, questionable. The subclavian was tied above the clavicle, the bleeding did not recur, and the patient recovered.

Remarks.—The four cases, Nos. 79, 81, 84, and 85, may be properly considered together. Four men of the greatest ability and eminence in their profession, tied the subclavian artery on account of a wound of the axillary artery; it is admitted that in all four cases the wound was below the origin of the subscapular if not of the circumflex branch. These vessels are acknowledged to be essentially necessary for the preservation of the life of the limb, the blood being brought round from the neck and shoulder by their means into the principal trunk, the canal of which was obstructed above by the ligature placed upon it. When blood had been so brought round into the main trunk above the hole in it, it is fair to inquire what was to prevent its flowing through it, and renewing the bleeding? The answer must be, nothing, unless a coagulum had accidentally formed to stop up the hole, which a very slight impulse or motion of the patient might remove, as it has been shown has taken place in many cases that have been related; or that healthy inflammation had taken place in the artery, and had clogged its canal by the usual processes of effusion, and consequent obliteration, both being matters of mere chance. In Sir C. Bell's case, No. 79, the blood did so come round the shoulder, did renew the bleeding, and thus destroyed the patient. In Mr. Stanley's case, No. 49, one inch and a-half, at most, of distance between two ligatures on the posterior tibial artery did the same thing; no reliance can, therefore, be placed on any presumption or idea that the collateral circulation will not always do so, and that the patient will not always be destroyed in a similar manner. In case No. 81, that of M. Haspel, the subclavian artery was tied for a wound of the axillary artery through the anterior fold of the arm-pit; the arm mortified, the limb was amputated, and the man died. The collateral branches failed to restore the circulation, and the bleeding was not therefore renewed; its failure caused the limb to mortify, and the man suffered an unnecessary painful operation and died. Death in either way. In case No 84 the subclavian artery was tied for a diffused but bleeding aneurismal swelling in the axilla after a wound. The collateral branches restored the circulation, and the bleeding was renewed. The wound was then laid open, the surgeon saw the artery bleeding freely, and concluded his operation by amputating the arm at the shoulder-joint, instead of placing two ligatures on the bleeding vessel, which might have saved the arm. The patient slowly recovered.

In this case, the operation on the subclavian artery was thoroughly useless; its utter insufficiency is honestly admitted by the operator, and the case should be borne prominently in the recollection of every surgeon. In case No. 85, the ligature on the subclavian artery above the clavicle succeeded in arresting the bleeding from the axillary artery, although the surgeon distinctly states that the opening in this vessel was below the origin of the three great communicating branches with the arteries above, and why the bleeding was not renewed by their bringing blood into the main trunk above the hole in it, no one can tell. It was on a matter of chance that this man's life depended; the surgeon hazarded the risk, and won. Of the four sufferers, the practice pursued failed in three cases; two died, one lost his arm at the shoulder-joint, and one only recovered, and this in the hands of four as able surgeons as any in Europe. If the question were asked, "Is the injury that befel these men in itself so deadly?" my reply would certainly be, "No, the mischief was not so much in the nature of the accident as in the defective nature of the means employed to remedy it. It is the surgical operation which is deadly, and not the injury."

Case 86.—Corporal Wm. Robinson, 48th Reg., was wounded at the battle of Toulouse by a shell, which rendered the amputation of his right leg necessary, and fractured the humerus of the same side, opening also extensively into the elbow joint. I amputated the arm close to the shoulder joint, on the 1st of May, eighteen days after the injury. At the end of the month there was only a line of incision, the lower part of the wound not being

quite cicatrised. The ligatures had all come away regularly. At this part a small abscess formed, and discharged itself in the beginning of June, arising, doubtlessly, from a portion of the tendon of the pectoralis major having sloughed after its separation from the bone by the operation. On his arrival at Plymouth, the little abscess formed again, and was opened on the 2nd of August, 1814, three months after the amputation; and the next day blood flowed so impetuously from this part as to induce the surgeons in charge to open the face of the stump, and to seek for the bleeding vessel, which they could not find, owing to the diseased state of the parts surrounding it. They therefore decided upon placing a ligature on the artery higher up and below the clavicle. The man had been brought from Bordeaux by the late staff-surgeon Dease, who had served with me on different occasions, and especially at Toulouse; and the operation was done by Mr. Downing, the deputy inspector of hospitals, and in the manner I had pointed out in the lectures on these operations I had delivered in one of the principal hospitals at Toulouse, after the failure of Case No. 9. An incision, commencing at the centre of the clavicle, was carried down to the inferior part of the axilla, directly through the integuments and the pectoral muscle; the pectoralis minor was then divided, and the artery exposed; two small arteries were tied which had been divided. Great difficulty was then experienced, and much time was lost from the want of an aneurismal needle sufficiently firm to keep its curve, which the silver-eyed probe they had would not do. The ligature was however at last placed on the artery, and came away in a reasonable time. Corporal Robinson was forwarded to me afterwards at the York Hospital, Chelsea, and again became the subject of a clinical lecture, given in proof of the advantages to be derived from this mode of operating. The only error committed was in searching for the artery so long in diseased parts on the face of the stump, instead of at once cutting down upon it an inch or more above its extremity, but below the pectoralis minor muscle, which might afterwards have been divided, and the wound enlarged upwards, if it were found necessary. If this operation had not succeeded, the ligature of the subclavian above the clavicle was a further resource, but as the artery was sound, with the exception of the end engaged in the face of the stump, there was no reason why a doubt should be entertained of the success of an operation, which was, in fact, attended with comparatively little risk to the patient.

It is immaterial how many incisions are made in the folds of the arm-pit or around the breast and shoulder, as long as the arm will hang on alive it is to be preserved. Those poor fellows who have survived the most desperate injuries of the kind know well the value of the under use of the arm, although the shoulder should be stiff. Amputation is moreover an opprobrium to surgery, which cannot be admitted but as a last resource—as the only means left untried of saving life.

I cannot, then, recede from the opinions formed on these points from the practice of the Peninsular war, and although I regret being obliged to differ from so many highly accomplished and able surgeons, I am obliged to declare that in no case in my opinion is amputation at the shoulder-joint admissible on account of a wound of the axillary artery, unless mortification of the extremity has taken place.

There is a very important point growing out from several of these cases, which must not be overlooked. It is admitted by the facts stated in many of them that the axillary artery was injured below the giving off of the subscapular and circumflex branches to the shoulder and parts around it. If a ligature had been applied on the main artery in cases No. 79, 81, 84, 85, at the part injured in the first instance, it would have been placed either above or below the circumflex arteries. If above them, it would or ought to have permitted the renewal of the bleeding through their collateral connections, and the operation would have been useless. If below them it would have been at the part injured, and a ligature above would have been unnecessary. Whether applied immediately above or below, it is said it would have prevented the consolidation of the artery by its proximity. This is a supposed fact I not only doubt, but entirely disbelieve on the ground of experience, founded on observation. It is a point on which I have ventured for many years to call in question the accuracy of most of my predecessors and contemporaries, and of the unsoundness of which I have given proof. It is my belief that if a ligature were placed on the axillary artery immediately below the origin of the posterior circumflex artery, that the orifice of this vessel would become obstructed in consequence of the extension of inflammation to it at the same time as to the canal of the main trunk. If this small artery were given off half an inch above the ligature, it would in all probability remain pervious, and in an healthy artery (although not in a diseased one), I do not think this degree of proximity would be of the least consequence in preventing the permanent obliteration of the extremity of the canal below it. The point on which a distinct answer must be given is, whether it is safer to apply a ligature immediately below or above the origin of the posterior circumflex artery, having the power of selecting either place? The answer is, it is safer to do so below, for the orifice of the artery will not interfere, it may be expected, with the consolidation of the main trunk under and above the ligature; while if tied above, the same orifice would open into an exposed and suppurating wound, in which the processes necessary for its closure might not take place. It might then bleed some days after the operation, and render the application of another ligature on the part injured necessary.

In my work on Gunshot Wounds and on the Operations of Amputation I have said, page 302, 3rd edit., 1827, "In the irritable and sloughing state of stump that has been noticed, hemorrhages

frequently take place from the small branches, or from the main trunks of the arteries, in consequence of ulceration; and it is not always easy to discover the bleeding vessel, or when discovered, to secure it on the face of the stump; for, as the ulcerative process has not ceased, and the end of the artery which is to be secured is not sound, no healthy action can take place; the ligature very soon cuts its way through, and the hemorrhage returns as violently as before; or some other branch gives way; another ligature is required, which is equally uncertain; and under this succession of ligatures and hemorrhages the patient dies. Surgeons have, in such cases, preferred cutting down upon the principal artery of the limb, in preference to performing another amputation, even when it is practicable; and they have frequently succeeded in restraining the hemorrhage for a sufficient length of time to allow the stump to resume a more healthy action. This operation, although successful in many cases, will under certain circumstances fail, and amputation become ultimately necessary; but the same objection of want of success may be made to amputation; and on a due comparison of these circumstances, I recommend the operation of tying the artery, in most cases, in the first instance; and if that prove unsuccessful, of resorting to amputation; but this practice is by no means to be followed indiscriminately. The artery is to be secured with reference to the mode of operating, as in aneurism; but the doctrines of this disease are not to be applied to it, because it is still a wounded vessel with an external opening, which truth I have more than once seen proved to the discomfiture of the surgeon.

"In the thigh the operation is less certain than in the arm, and especially if it be not the main artery that bleeds; for the branch from which the hemorrhage proceeds may come from the profunda, and tying the artery in the groin on such opinion would be doing a serious operation, and one which would probably not succeed, for the anastomosing branches would restore the circulation in the stump in a short time, and again establish the bleeding. If it is the femoral artery that bleeds, and the ligature is applied high, it is very liable to a return of the hemorrhage. To obviate these difficulties, the part from which the bleeding comes should be well studied, and the shortest distance from the stump carefully noted at which compresses on the artery command the bleeding, and at this spot the ligature should be applied, provided it is not within the sphere of the inflammation of the stump. In case the hemorrhage should only be restrained by pressure above the origin of the profunda, and repeated attempts to secure the vessel on the surface of the stump had failed, I would prefer amputation, when the strength of the patient would bear it, to tying the artery in the groin, which I do not think would be successful; and the patient would be then in a less favourable state for amputation.

"When hemorrhage takes place after amputation at the shoulder-joint, it is a most dangerous occurrence, more particularly if it occurs in consequence of ulceration. In no case is the artery to be struck at by the needle, but an incision is to be made through the integuments and great pectoral muscle, when the artery may be readily exposed, and a ligature placed upon it without difficulty anywhere below the clavicle. If the state of the stump in any of these cases depend upon the bad air of the hospital, I would expose the patient to the inclemency of the weather rather than allow him to remain in it; for I know that the effects of any exposure must be less certainly fatal to the patient than a continuance in an unhealthy atmosphere.

"It often happens, in cases of this kind, that the stump has not united, or in opening out has given rise to a protrusion of the bone, forming a conical stump, the skin has retracted, and the face of the stump, in granulating, is exposed and becomes irritable. In crowded hospitals, hemorrhage from the face of such a stump is not unfrequent, and often causes a great deal of trouble to the surgeon and much distress to the patient. It is not a direct bleeding from a vessel of sufficient size to be discovered and secured, but an oozing from some part of the exposed granulations, which are soft, pale, and flaccid. On making pressure on them, the hemorrhage ceases, but shortly after dressing the stump it reappears, and even becomes dangerous. After the battle of Salamanca, and those of the Pyrenees, I had several instances of it; there were not any at Toulouse. After the battle of Waterloo they were sufficiently numerous.

It is affirmed in France, and a statement to this effect is made in the Gazette Médicale de Paris, for the month of May, 1846, that a secondary hemorrhage, arising from inflammation, ulceration and even sloughing of a part, not only on the surface of a stump, as in the instances I have adverted to, but in an ordinary wound, such as in the calf of the leg, the principle to be pursued is to tie the femoral artery, as was done by Dupuytren in Case 42, and the reason given is that the artery is suffering already from inflammation, which has rendered its coats more (*secables*) easily divisible by the ligature, and less capable of taking on those actions which were necessary for the firm adhesion of its sides. Of this last point there can be no doubt, whence the precautions given above, to place the ligature on the artery an inch or two higher up than the part to which the inflammation or other disease had extended. The inflammation which the vessel had already suffered from would have passed that stage likely to end in the cohesion of the sides or the edges of its extremity, and the occlusion of its canal. A ligature cannot be expected to succeed when applied to an unsound artery, although it frequently will do so, for no one can estimate, a priori, the extent and nature of the disease, which may be existing in it. When surgeons write of their having felt and heard an artery crack and crunch and give way under a ligature, applied with a moderate degree of force, they must have met with vessels far advanced in disease. When I first acted upon these princi-

ples, during the war in the Peninsula, and published them some thirty years ago, I was not aware of the extent of my own merits, and most assuredly did not expect to see my opinions claimed and recorded as those of modern surgeons in France, and opposed to what the editor of the Medical Gazette of Paris considers to be those of the best English surgeons, which, as far as I know, do not generally differ from what I have said regarding the state of the artery on the face of a diseased stump or other part which had been the seat of injury. That there is a strong inclination among a few to follow the practice recommended by the editor of the Gazette Médicale, and to tie the artery at a distance, I admit; but this I have forbidden, except as a last resource, and have, I conceive, supported with sufficient proof.

Mr. Abernethy supposed that a vessel of the size of the anterior circumflex artery, which is usually smaller than the posterior, and from which it often arises, or other vessels of even less dimensions coming off from a large trunk, would bleed with much greater vigour than others of similar dimensions, which were given off by secondary branches. He was led, I understand, to form this opinion from seeing the pertinacity with which small arteries coming off directly or nearly directly from the axillary artery, and going to small glands in the arm-pit, bled when these glands were removed by operation, in consequence of their connection with the female breast. I apprehend that arteries going to diseased or even inflamed parts do not retain and maintain their contractile powers in a similar manner to those which are going to sound parts. A change has manifestly taken place in them; they are usually larger than in their normal state, and when cut or divided pour out a larger stream of blood, and are more disposed to continue to bleed, unless nature is aided by art. Surgeons are well aware of the difficulties which are often experienced in suppressing the flow of blood from small arteries in the most distant parts of the body, such as the foot and hand, and more especially in vessels which, having once ceased to bleed, have been unable to prevent its renewal. An artery on the side of an inflamed finger will propel its jet of blood quite as far, if not farther than one of the same size in the arm-pit, and I place no reliance whatever on the supposition which, I understand, emanated from Mr. Abernethy, more particularly as it has led to another which has proved a greater mistake, and a great evil, viz., that in the event of one of these small vessels being divided half an inch or even more from the main trunk, that this main trunk must be tied, and not the branch—a practice which cannot be too forcibly condemned. Many scores of times, I had almost said hundreds, have I tied or seen tied by my direction small arteries under these precise circumstances, and with the greatest success.

In my work on the Operations of Amputation at the Hip-joint, &c., I have cautioned surgeons against an evil of this kind (p. 280, 3rd edition):—"Sometimes, after the principal artery of a limb has been secured, hemorrhage will continue from its sides above the ligature, arising in general from some branches which have been cut shorter, or have retracted more unequally than the principal trunk. Instead of puzzling at this for ten minutes, screwing and unscrewing the tourniquet, and at last diving with a needle, and laying the foundation for a secondary hemorrhage by pricking the artery, let it be transfixed, and pulled out by the tenaculum, and separated a little with the scalpel from its connections, as high as those troublesome openings, when a ligature is to be put upon it, and the end of the artery cut off with the scissors; and I never saw this ligature pushed off a large artery when properly tied. This inconvenience is in general avoided by the division of the muscles, the operator taking care to divide the principal artery at one stroke of the knife, and with it half an inch at least of surrounding substance on each side, when these small vessels will give no trouble. This is another precaution which may appear trifling, but is often of great value.

"When there is bleeding from any particular part, both venous and arterial, in larger quantity than can with propriety be overlooked, the part ought to be pressed upon by the points of the fingers, one on each side, or rather separated. The blood should then be absorbed by a small piece of sponge, when the vessel will be found retracted within the muscular fibres surrounding it, which prevent the flowing of the blood per saltum. If this fail, a slight touch with the scalpel will show the vessel, and save much unnecessary delay. I have seen the arteries of a stump occupy a person a quarter of an hour, and were not even then properly secured."

Case 87.—Mr. Stanley operated upon a femoral hernia in a man sixty-three years of age. At the time of the operation there was no unusual bleeding. About an hour after it the bandage which had been placed over the wound was observed to be soaked with blood. On removing the bandage large clots of blood were found not only filling the cavity of the wound, but also extending upwards upon the walls of the abdomen. The wound was filled by compresses of lint, and a bandage firmly bound over them. There was no return of the bleeding. On the second day after the operation the man died from peritonitis. On examining the body the obturator artery was found to arise by a common trunk with the epigastric, but it passed on the outer side of the mouth of the sac, and was therefore out of the way of injury. An artery the size of a thick sewing thread arose from the epigastric, and passed across the front of the mouth of the sac. This was divided, and it was the only artery discovered, in a careful examination of the parts, which could have furnished the profuse flow of blood that took place shortly after the operation for the hernia.

Remarks.—This case was supposed not only to support, but to demonstrate at the time the truth of Mr. Abernethy's views on this point, and some of the young gentlemen about the hospital announced

that Mr. Stanley was about to tie the external iliac above and below the origin of the epigastric and circumflexa ilii arteries, in accordance with such opinion. Mr. Stanley was however content to apply a compress and bandage, as in ordinary cases.

Case 88.—I performed the operation many years ago at the York Hospital, Chelsea, of removing the left testis, and tied the spermatic, the cremasteric and the deferential arteries, the three which usually bleed, and left my patient. Three hours afterwards the assistant-surgeon on duty sent a messenger to inform me that there had been some bleeding, that he had opened the wound, and that the man's bowels were coming out. Perfectly satisfied that I had made no mistake, I nevertheless went to Chelsea in some trepidation, and when the dressings were raised there certainly did appear to be a large double fold of intestine protruding to the extent of four or five inches. On further examination this proved to be coagulated blood, which, under the pressure of the external parts brought together by ligature, had simulated the appearance of intestine. On its removal the little vessel from which it came bled vigorously. It was in the integuments near the external ring, and apparently a branch of the external pudic artery coming from the thigh. A single thread of ligature settled the matter, and the man was soon discharged cured.

It is inexcusable enough to be afraid of large vessels; it is perfectly ridiculous to be afraid of small ones. In almost all cases of amputation at the shoulder-joint, the posterior circumflex artery is cut off at rarely more than an inch from its origin, frequently less. The anterior circumflex is often even shorter; yet these vessels once fairly tied never give any trouble. When secondary hemorrhage has taken place it is not recorded that the bleeding came from either of them. It has always been from the main trunk. They have remained closed, which they should not have done, if this hypothesis were in any way well founded. The operation of amputation at the shoulder-joint would be a fatal operation if not performed above the origin of these vessels, which it rarely is, and yet no great operation can be more successful. I have not within my recollection known a ligature fail on a branch half an inch distant from the main trunk of a great artery, and most certainly such an evil could not have occurred frequently without my having remarked it, as well as the inconvenience arising from their being cut somewhat shorter, on which account I have directed their removal altogether, with that portion of the main trunk from whence they sprung. I am therefore, I consider, entitled to express my disbelief not only in the hypothesis, but in what is of more consequence, in the propriety of the practice intended to be deduced from it. It would be a great error, in my opinion, implicating the limb, and perhaps the life of the individual, to tie the axillary artery for a wound of the posterior circumflex half an inch from its origin. It would be equally dangerous to tie the external iliac for a wound of the epigastric or of the circumflexa ilii arteries. It would be infinitely worse to do it for a wound of a more superficial vessel in the thigh, unless as a last resource, however close it may arise from the femoral artery. It is much to be regretted that it should be necessary to argue such points as these in 1846, which were apparently overturned and even derided in 1816. The editor of the Gazette Medicale de Paris may indeed fairly sneer at English surgery when compared with that of France if such are to be its precepts.

The axillary artery from its passage over the first rib as subclavian until it leaves the edge of the pectoral muscle to become humeral, is anatomically divided into three parts:—The first between the lower margin of the clavicle and the upper edge of the pectoralis minor muscle, which space is somewhat more than an inch in length under ordinary circumstances. The second part lies under the pectoralis minor muscle, is about the same length, and is covered or concealed by it. The third part extends from the lower edge of the smaller pectoral muscle to the lower edge of the greater, and is longer than the other two together. A vertical or perpendicular incision three inches long through the lower half or inferior border of the anterior fold of the arm-pit, in the direction of the axillary artery, would include the common integuments and the great pectoral muscle, and might be enlarged upwards if necessary, the finger being used as a director. It would completely expose the whole hollow or pit of the arm, with the smaller pectoral muscle lying across its upper part. The finger introduced under this upper part would enable the operator to divide it also if necessary, or to draw it upwards, when the artery, vein, or veins, and the plexus of nerves, might be traced up to the first rib without difficulty. The artery if open would bleed when pressure was taken off the subclavian above. With every part thus fully exposed the artery would be as easily, nay, more easily, separated from its surrounding or accompanying nerves and veins, and a ligature placed around it, than in any other way. The lower end of the cut or divided vessel might then be sought for, and secured in a similar manner.

Compare with this very simple operation the account given of that which is usually performed, taken from the best book on the subject:—

"The patient may be seated, with the shoulder of the affected side inclined backwards: an assistant should be placed behind the patient, with instructions to compress the subclavian artery in the event of hemorrhage; a semilunar incision is to be made about three inches long through the integuments, commencing about one inch from the sternal end of the clavicle, and extending towards the acromion process as far as the anterior edge of the deltoid muscle, avoiding the cephalic vein and thoracica-acromialis artery; the clavicular portion of the pectoral muscle is thus exposed, and is to be divided in the same direction, and to the same extent, as the external wound; the flap thus formed is then

to be everted, and some loose cellular membrane being detached, the superior edge of the smaller pectoral muscle will be exposed; in this stage of the operation, several branches of the thoracic arteries are in danger of being wounded. A director should then be insinuated beneath the strong fascia extending from the subclavian muscle to the coracoid process, and a portion of the fascia divided. Some loose cellular membrane and a few small blood vessels being detached with the blunt extremity of a director, the axillary vein will be exposed; this vessel should be pressed inwards towards the ribs, and the artery will be felt or seen pulsating; it must be carefully detached from the nerves for a short distance, and the aneurism needle passed under it, the needle being directed from the thoracic to the acromial side. In applying the ligature, it is to be recollected that one of the large nerves of the plexus inclines to the front of the artery, and having a pulsation communicated to it, might be mistaken for the artery itself. Even on the dead body, this operation is by no means easily performed; but on the living subject it must be attended with considerable difficulty, particularly in corpulent persons: the depth at which, in such individuals, the artery lies, together with its complicated relations, must render the application of a ligature to it peculiarly hazardous. It appears to me that few cases can occur in which the operation now described ought to be preferred to that of tying the subclavian artery external to the scaleni muscles; at the same time it must be admitted, that an extensive wound passing through the pectoral muscle, may expose the axillary artery, so as to render the application of a ligature to it in this situation comparatively easy."

Remarks.— This description is critically and anatomically correct; no man in the united empire could do the operation better than the author of the work from which I have extracted it; and yet the operation is so thoroughly dangerous and useless, and so contrary to true principles, that it ought never to be performed. It ought to be struck out of the catalogue of operations. I know it to be dangerous, because I am aware of two persons having died under it, before the ligature was applied, the axillary vein in both instances having been injured. In aneurism from disease of the axillary artery, the operation should always be done above the clavicle; in a case of wounded artery, at the spot in which the artery is wounded below it.

Case 89, by Mr. Quain, from the Lancet of May 2, 1846.—J. S., aged twenty-four, fell upon an iron rail which was forced into the axilla, and was admitted into University College Hospital under Mr. Quain on the 4th of March. He was faint from the loss of blood, estimated by himself at two quarts, although the bleeding had ceased. The wound, about an inch in length, was in the centre of the arm-pit, and pulsation was distinctly felt in the radial artery. On the 6th, no pulsation could be felt below the wound in any of the arteries; nor, until the 11th, when it was slightly observable in the radial artery. After this the patient gradually recovered, and was discharged, cured, on the 27th of March.

Mr. Quain stated, in a clinical lecture, that the quantity of blood lost was doubless exaggerated, and that if arterial hemorrhage had recurred he should have divided the pectoral muscle in the track of the wound, and secured the bleeding vessel above and below the opening in it.

Remarks.—This case essentially resembles cases No. 2 and 82. The presence of pulsation during the first two days in the radial artery, shows that the canal of the artery was not obliterated in the first instance, and that it only then became obstructed, from inflammation taking place in the brachial artery, or extending to it from a small vessel divided near its origin from it. The restoration of the pulsation in the radial artery on the seventh day after the accident shows the establishment of the collateral circulation.

The non-interference of Mr. Quain, beyond the application of a small compress and bandage, and of keeping the arm quietly supported in a sling by the patient's side, is consistent with that principle of surgery I have endeavoured to inculcate, which forbids that a man should be cut on the speculation of what may happen if he is not. If the bleeding had recurred, there would then have been a reason for interference, and Mr. Quain says he would have placed a ligature on the artery above and below where it was wounded, after having divided the pectoral muscle — an operation which would have been worthy of his high attainments in anatomy and surgery, and an example which it is to be hoped all surgeons will hereafter follow as a precept in surgery.

Let us however suppose that the external wound was not direct, and that some two or three ounces of blood had been retained in the cellular membrane under the integuments; would this have rendered an operation on the subclavian artery, above the clavicle, a preferable operation? I do not believe there is now a surgeon in England will answer in the affirmative. Let us go one step further, and suppose that the external wound had closed—a circumstance I have shown to have happened in many cases, and that a small pulsating tumour, containing three, four, or six ounces of blood, had become perceptible under the cicatrix on the day he was discharged, that is, thirteen days after the receipt of the injury — what difference would there have been in the case from the first day? The answer must be, simply in the closing of the external wound, for no one will suppose that the artery could be diseased. I shall now ask whether any one will say that the trifling circumstance of this external wound having healed, ought by any possibility to render a different operation necessary? That instead of the same simple division of the parts to expose the hole in the artery, and to tie it—an operation of no difficulty and of little danger—the deadly operation of tying

the subclavian artery above the clavicle, should be resorted to. That, because the hole in the skin had healed, the patient's life was to be placed in jeopardy by an operation which has hitherto destroyed every other person on whom it has been performed. I cannot answer for what all sorts of surgeons may do, or consent to have done upon themselves, but I venture to assert that there is not a gambler existing who can calculate chances that would suffer such operation to be done on himself when those chances were fairly explained to him.

When Mr. Medhurst was tried for the murder of his friend, in a fit of passion, by stabbing him in the belly, the solicitor for the defence offered me any sum I pleased to ask to go into court, and prove that the defunct had been badly treated by his surgeons. I refused, and have invariably refused all such applications on the ground that the surgeons had done their best, and that it was not for me who had had greater opportunities of acquiring knowledge in these particular injuries, to find fault with them, who had been originally taught no better, and had not had opportunities of acquiring further information. In the treatment of wounded arteries you are now all taught better, provided you are pleased to learn, and if hereafter any of you will commit such errors as I have protested against, and so urgently denounced, I shall not refuse to give my aid in having you legally admonished.

LECTURE V.

Non-applicability of the Hunterian theory and operation in cases where the wounded artery cannot be seen, in consequence of the wound not being direct; Statistics of the operation for the ligature of the common iliac artery; Statistics of the operation for the ligature of the external iliac artery; Objections to the latter operation in cases of wounds of the femoral artery; case of diffused popliteal aneurism; Ligature of the femoral artery at the maryin of the sartorius muscle; Secondary hemorrhage; Ligature of the femoral artery immediately below Poupart's ligament; Recurrence of hemorrhage from the seat of the first ligature; Ineffectual search for the bleeding vessel; Amputation; The artery ulcerated through; Secondary hemorrhage from the groin; Ligature of the external iliac artery; Recurrence of the hemorrhage; Ultimate cure by pressure; Remarks on the case; The theory that a ligature placed on such an artery as the femoral would fail, if in the immediate vicinity of a large branch, unfounded; The fear of fatal hemorrhage from the division of the external containing parts of a small spurious aneurism, unworthy comment; No operation should be performed on a wounded artery, until it bleeds through the external wound; Case of a wound of the femoral artery by a musket-ball; Apparent cure of the wound; Formation of a varicose aneurism; Ligature of the external iliac artery, and death from mortification; M. Delpech's case of wound of the femoral artery, with consecutive aneurism; Ligature of the external iliac artery, and death from mortification; Case of wound of the femoral artery by a musket-ball; Ligature of the external iliac artery; Death from typhoid fever; Mr. Liston's comments on this case; Dr. Buchanan's case of ligature of the femoral, inguinal, and external iliac arteries for secondary hemorrhage, consecutive on the separation of sloughs; Case of wound of the femoral artery; Occurrence of dry white gangrene; Secondary hemorrhage; Ineffectual ligature of the external iliac; Enlargement of the wound, and ligature of the lower end of the wounded vessel, with arrest of bleeding; Death from exhaustion; Remarks on the case; Should the line of demarcation in cases of mortification from wounded arteries be waited for, before amputation is performed? Place of election for the performance of amputation; Mr. Norman's case of wounded artery in the upper and outer part of the thigh; Secondary hemorrhage; Ineffectual search for the wounded artery; Ligature of the external iliac artery unavailing; Ligature of the femoral artery below Poupart's ligament; Arrest of the hemorrhage; Loss of the leg from mortification caused by the ligature of the external iliac; M. Lutens' case of ligature of the external iliac artery for a wound of the femoral, some lines below Poupart's ligament; Return of the hemorrhage; Ineffectual application of a second ligature on the external iliac higher up; Incision of the diffused aneurismal swelling, and ligature of the femoral below the profunda; Death from mortification; Case of wound of the femoral artery in the lower part of the upper third of the thigh; Formation of a large diffused aneurism; Ligature of the femoral artery below Poupart's ligament; Secondary hemorrhage; Ligature of the external iliac; M. Jobert's case of ligature of the femoral artery below Poupart's ligament, for a diffused aneurism of the same artery under the sartorius muscle, caused by a wound; Death from repeated hemorrhage; Dr. Portal's case of hemorrhage after an operation on the groin; Ligature of the external iliac; Return of the hemorrhage; Ligature of the femoral artery and vein at the site of the wound; Arrest of the hemorrhage; Death from peritonitis and gangrene; Dr. Murray's case of aneurism from a blow; Ligature of the femoral below Poupart's ligament; Violent secondary hemorrhage; Ligature of the external iliac; return of the hemorrhage from the lower part of the injured vessel; Cure by compression; Baron Dupuytren's case of femoral aneurism from a blow; Failure of compression; Ligature of the external iliac artery; Return of pulsation in the aneurism on the eighth day; Secondary hemorrhage from the lower end of the wound; Ligature of the iliac artery higher up; Return of the hemorrhage; Cure by compression; Remarks on the case; Case of wound of the inguinal artery; Ligature of the upper end of the wounded vessel; Fatal secondary hemorrhage; Case of ulceration of the external pudic artery, following a sloughing bubo; Secondary hemorrhage; Application of the actual cautery and pressure; Return of the hemorrhage; Extension of the ulceration to the femoral artery; Ligature of the external iliac artery; Symptoms of mortification; Successful amputation close to the trochanter; Dr. Warren's case of secondary hemorrhage after amputation of the thigh; Ligature

of the femoral artery; Return of the hemorrhage; Successful ligature of the femoral artery an inch below Poupart's ligament; Case of femoral aneurism opened by mistake; Amputation, and death; Case of inguinal aneurism opened by mistake; Ligature of the external iliac artery; Fatal gangrene; Remarks on the case; Case of inguinal aneurism, extending under Poupart's ligament; Successful ligature of the external iliac artery; Death eight years afterwards; Mr. Canton's anatomical description of the collateral vessels; Dr. Horner's case of ligature of the external iliac artery for inguinal aneurism; Incision of the sac, and removal of the coagula, followed by formidable hemorrhage; Division and ligature of the femoral artery below the sac; Hemorrhage from the upper end of the artery, and application of a ligature on it; Cessation of the hemorrhage; Death from inflammation and suppuration behind the peritoneum and external iliac artery, up to and behind the right kidney; Probable source of the hemorrhage from the branches of the profunda, with those of the internal iliac, and from the epigastric and circumflexa ilii; Remarks on the case; Dr. Horner's case of varicose femoral aneurism from a pistol-shot; Ligature of the femoral artery at the injured part; Mortification of the leg, for which amputation was performed; Consecutive formation of an aneurism at the extremity of the artery; Puncture of the sac; Consecutive hemorrhage, arrested by the application of several ligatures around the sac; Fatal recurrence of mortification; Dr. Brainert's case of inguinal aneurism following a fracture of the femur; Successful ligature of the external iliac.

Two women who had each borne a living child appeared before Solomon on the death of one of the children, each claiming the survivor as her own. The great lawgiver, unable to decide in the first instance which was really the mother of the living infant, desired that it should be divided by the executioner, and that half should be given to each of the claimants. To this the false parent acceded, but the real one, impelled by that affection which is so natural to a mother, gave up her right and her child rather than it should be sacrificed. Solomon, thus made aware of the real parentage of the infant, awarded the child to her who had shown herself so deeply interested in its welfare. I am in the position of the real mother with relation to the treatment of wounded arteries. It is now conceded, I believe, by all English surgeons that when an artery is seen bleeding in the bottom of a wound, that two ligatures ought to be placed upon it, one above, the other below the injured part. It is however attempted by some few to maintain a part of the Hunterian theory and practice, by affirming that when the artery cannot be seen in consequence of the wound not being direct, although it bleeds, or is supposed to be about to bleed, or to form a spurious diffused traumatic aneurism, having an external opening, this theory and practice may be adopted in its treatment. Its advocates, beaten from their first claim of the whole of the theory, are now reduced to contend for half, or for even a part. I cannot however yield them one single point. I totally deny the justice of every part of their claim, and declare without hesitation that the operation of tying the external iliac artery for a wound of the femoral must in general be not only ineffectual, but often fatal; and that if a person should escape with life and limb, he only escapes by that sort of accident which every one acknowledges to have been most fortunate, when a man in a gale of wind is carried off the deck of his ship by one wave of the sea, and is thrown back by another—a consummation always to be desired in such cases, but rarely to be expected. One party is right and the other wrong. It is a point upon which there can be no compromise. The life of man is in the mean time the shuttlecock of these contentions. The profession can decide this point, and its voice should be heard. It should, like Solomon, decide for one or the other.

The operation of placing a ligature on the common trunk of the iliac artery has been performed certainly fourteen times, and has succeeded in six instances—a success which would have been considered as really wonderful, as the operation would have been thought to have been impracticable some three score years ago. In two of the eight the peritoneum was necessarily opened, and they may be fairly omitted in the calculation of averages; so that the proportion of recoveries to deaths was equal, six to six. Of the six deaths four were from hemorrhage, and two from inflammation of the peritoneum and of the cellular membrane behind, as high up as, and around the kidney. The fourteen operations were performed by Messrs. Gibson, Mott, Crampton, Liston, Guthrie, Salomon, Syme, Deguise, Perigoff, Post, Stevens, Peace, Stanley, Hey—six American, five British, one French, and two Russian or German surgeons.

Mr. B. Phillips has shown the mortality in eighty-six cases of ligature of the external iliac artery to be twenty-one, or one in four. The deaths in proportion to the recoveries are only one-fourth as great as in the operation on the subclavian artery, and are as nearly as possible equal with respect to others which have been performed for all sorts of cases on the femoral artery at the lower part of the upper third of the thigh. There is no objection, then, to the external iliac artery being secured by ligature in cases of aneurism of the femoral artery, for which complaint it has been principally done, on the score of greater danger. The principal objections to it in the case of a wound of the femoral artery are—

1. Its inefficiency, in consequence of the bleeding being renewed from the wound in the artery at the moment, or after the interval of one or more days, by the restoration of the circulation in the vessel, through the medium of the collateral branches.

2. The occurrence of inflammation of or behind the peritoneum.

3. The greater probability of mortification of the extremity after the operation on the external iliac

artery than on the femoral, but which, I trust, may hereafter be materially obviated by the continued gentle friction on the leg and foot, which I have recommended as so beneficial.

The femoral artery high up in the thigh, or in the first three or four inches of its course, is the stronghold of the Hunterian theorists. They have made their last stand on this part, and on this their principle must be approved and maintained, or condemned and abandoned. Their grounds of defence are two :—

1. That this is a part of the vessel on which the application of a ligature is not usually followed by success, owing principally to the uncertain origin of the profunda artery which is given off by it somewhere within this distance.

2. That an operation to divide the parts which cover the artery, in order to expose the wound in it, might lead to the death of the patient from loss of blood.

The hypothesis that the upper part of the femoral artery is a very dangerous and unsafe part on which to apply a ligature, originated I believe with Mr. Hadwin, late house-surgeon of the Leicester Hospital, who published a case of Mr. Hewson's, one of the surgeons, through Mr. Quain, in the 20th volume of the Transactions of the Royal Medical and Chirurgical Society, on which, and on the inferences drawn from it, Mr. Quain seems to rely, for the opinion he supports, that the external iliac artery should be secured by ligature in preference to the femoral artery at the part wounded.

Case 90.—A man was admitted into the Leicester Hospital on the 18th July with a popliteal aneurism, which had probably been ruptured, so as to become in fact diffused, for which the femoral artery was tied at the margin of the sartorius muscle. On the 30th, bleeding occurred from the wound to eight ounces. Pressure was applied. On the 31st, the bleeding returned with such violence that the femoral artery was tied immediately below Poupart's ligament. The pulsation at the seat of the first ligature ceased, but in the evening there was a slight oozing of blood from the first wound.

Aug. 2. Bleeding recurred from the same spot; was arrested by pressure, but as soon as it was removed blood flowed in a stream as large as a quill. The wound and partial cicatrix were laid open, and an ineffectual attempt was made to find the mouth of the bleeding vessel. The limb was then amputated above the lower ligature, which was found on the lower end of the artery, which was quite separated from the upper end, the mouth of which was open.

On the 21st the wound in the groin was observed to bleed, and was arrested by compression ; it again recurred, and on the 22nd, on its being renewed, the external iliac artery was tied. On the 28th the wound at the groin again bled. It was not thought right to tie the iliac in another place, and the pressure which had failed before was again resorted to, and with success, the patient being discharged on the 101st day.

Remarks.—The artery diseased, in all probability as high as the external iliac, was incapable of taking on healthy actions. The first ligature applied did not succeed in obliterating its canal, because these healthy actions could not take place in a diseased part. The second ligature below Poupart's ligament failed for a similar reason. The third, placed higher up, succeeded, the artery being in a more healthy state, as it usually is in cases of aneurism of the femoral artery. The point in this case most worthy of notice, and to which particular attention should be paid, is the manner in which the collateral vessels brought the blood round into the main trunk of the limb, and re-established the circulation in it, reducing the extremities of the vessels from which each of the ligatures had come away to the state of wounded vessels, although another ligature was still on the same vessel above the part which bled. This person's life was at last only saved by pressure on a bleeding point or end of the artery, the ligature above being unequal to prevent or arrest the flow of blood from it. The conclusion which Messrs. Hadwin and Quain appear desirous of drawing from this case, as regards wounded and otherwise healthy arteries, is overthrown and disproved by the case itself, which actually shows the imperative necessity of tying arteries that bleed as near as possible to the bleeding points, and that a ligature placed above or at a distance is unequal to restrain the blood from flowing through an open extremity lower down, in consequence of the facility with which the collateral vessels, in many instances, re-establish the circulation below the ligature. That a ligature placed on an unsound artery should fail of success, is what every surgeon must expect. That it should fail at this spot, not because the artery was unsound, which was the fact, but because the profunda artery originated somewhere near it, is merely hypothetical and unphilosophical, one good reason being usually considered sufficient, without the aid of another of a very uncertain character.

I affirmed in 1815 that there was no foundation for the theory which declared that a ligature when placed on an artery such as the femoral would fail, if in the immediate vicinity of a collateral branch, in consequence of the flow of blood through this vessel preventing the obstruction and consolidation of the main trunk for a distance sufficient to enable it to resist the impulse of the blood from behind. It is a delusive theory, hastily formed, and pertinaciously retained contrary to observation and experience. The observations I have before made in Lecture 4 overthrow it in a manner which is perfectly irresistible, independently of the many other instances in which the same facts have been known to take place.

The origin of the profunda is easily ascertained during an operation, provided it is within half an inch of that part of the main trunk on which it is intended to apply a ligature; and it having been ascertained that it is not within this distance, the surgeon need give himself no more concern about it, more especially when the arteries are all sound,

as is usually the case when they are accidentally wounded.

It will be proved in the cases which follow, that when a ligature is placed or has been placed on the external iliac artery, it is frequently applied in a similar situation with respect to the orifices of the circumflexa ilii and epigastric arteries. These vessels are not invariable in their origin; it differs in many instances; the ligature is generally placed between them, and at an unknown distance from either. The theory of the danger arising from the proximity of the origin of a branch is as good in one case as in the other; the actual danger, whatever it may be, is as great. The objection in one instance is quite as good, and no better than in the other, and it is, in my opinion, practically worth little or nothing in both. The essential point is that the artery in aneurism is more sound when iliac than when femoral. The soundness in wounded arteries is alike in both, and a ligature is as little likely to fail in one as in the other, whilst the danger of peritoneal inflammation does not exist when the ligature is applied to the femoral artery, and that from mortification of the extremity is infinitely less. If the ligature of the femoral artery should fail, as well as pressure properly applied, the iliac artery becomes a further resource. Mr. Key has shown in the Guy's Hospital Reports, in a case in which the subclavian artery was tied above the clavicle, and which he had the opportunity of dissecting twelve years afterwards, that the ligature was actually applied close to the origin of a large branch from the subclavian artery, and that it had not interfered with its consolidation; and I should think that, if these observations are duly considered, with the remarks I made on this point in my last lecture, the theory may fairly be considered as worthless with regard to wounded arteries.

In every case I have related or shall relate the loss of blood is stated to have been considerable at the moment of injury, but no reliance can be placed on the computation usually made as to the quantity. Operations were rarely done in any of these cases until rendered absolutely necessary by further losses of blood after repeated hemorrhages, and as to the fear said to be entertained of dividing the containing external parts of a small spurious aneurismal swelling, in order to look at the hole in the vessel, lest it should bleed so as to destroy the patient, it is totally unworthy of a comment. I cannot understand how any one can entertain such an apprehension. If it had not been advanced as a reason by men of undoubted ability, I should have looked upon it in these days, and after what has been done in all quarters of the globe, as an acknowledgment of incapability or imbecility; as it is, it is only, in my humble opinion, a bad reason put forward in a worse cause for the want of a better. The great principle of surgery on this point must never be forgotten, that no operation should be done until the wounded artery bleeds through the external wound, and then it becomes imperative. It must then be done on the spot, aye, and even if the iliac artery had been previously tied, or the patient will be lost.

Case 91.—A soldier of the 38th regiment was wounded by a musket ball at the battle of Waterloo, which entered the thigh about three inches below Poupart's ligament, and lodged. He lost a considerable quantity of blood at the time, but the wound healed kindly, and he was discharged, cured, in about four weeks. On the 18th of August, two months after the receipt of the wound, he complained of a tumour, about three inches in length and two in breadth, which extended to within an inch of Poupart's ligament. The pulsation was powerful, and gave the feeling of a strong thrill with considerable resistance to the propulsion of blood. The cicatrix of the original wound was situated upon the tumour towards its upper part. It was deemed expedient to place a ligature on the external iliac artery on the 28th of August, and the man died on the 1st of September of mortification, which had extended to some three inches above the knee. The operation was performed with great dexterity, and no evil had resulted from it at the part operated upon. The ligature was on the artery *a quarter of an inch above the origin of the epigastric, and about an inch below that of the circumflexa ilii.* A small communication was found between the femoral artery and vein at the side of the tumour, about an inch and a half below the origin of the profunda. The covering of the aneurism was formed by the sheath of the vessel and the fascia of the thigh. The profunda was sound. The whole limb was in a state of gangrene.

Remarks.—The operation on the external iliac artery was done on the aneurismal theory of Mr. Hunter, and the man lost his life from mortification, the collateral branches not having had time to enlarge so as to carry on the circulation. If the small tumour had been laid open and the artery secured above and below the opening in it, mortification would not, it may be presumed, have taken place. The opening in the vein, if it became necessary to operate upon it, should have been closed by passing a tenaculum beneath its cut edges, and surrounding the small piece thus bruised by a single silk thread, which on separating need not necessarily have destroyed its permeability. Three or four days would at all events have been gained before any bleeding would have taken place, in which case a ligature might have been placed around the vein, and the collateral arterial circulation might by that time have been established. This case teaches the important lesson, that when an aneurismal tumour is rapidly formed after an injury, and operated upon at an early period, the collateral branches will not always have had time to enlarge to such a degree as to carry on the circulation, and the patient is lost, when a little more delay and a different operation might have been attended with a favourable result, the artery itself, with the exception of the hole in it, being sound. It is now admitted, when the vein is wounded and a varicose

aneurism forms, that the operation must be done at the part injured.

Case 92.—M. Delpech about the same time, July 15, 1815, tied the external iliac artery for an aneurism similarly situated. The patient died from mortification.

Case 93.—Osten Cooper, of the 2d battalion 1st regiment of guards, thirty years of age, was wounded at the battle of Waterloo, on the 18th of June, by a musket ball, which entered the left groin a little below Poupart's ligament, passed through the thigh, and was cut out the following day a little above the smaller trochanter. Nothing remarkable occurred until the 29th, when the slough from the anterior wound came away, and was followed by so frightful a hemorrhage as to leave no doubt whence it proceeded, nor (from the wound being so high up) any alternative in the opinion of the surgeon as to the means to be adopted for stopping it. The external iliac was therefore exposed, secured by a double ligature, and divided; the ends of the artery immediately retracted more than half an inch. The sides of the wound were then brought together by adhesive straps, and the operation was finished without loss of blood. Arterial action was so high, that twenty ounces of blood were taken from the arm; the limb was rolled in flannel, and warm jars kept to the foot.

Remarks.—This man died on the 5th of July, seven days after the operation, of fever of a typhoid character then endemic in the country, and which from the second day left little hope of recovery. The operator in concluding his statement, which I published at length in my book on the Diseases and Injuries of Arteries, says, "In this case the necessity of the operation is evident, and, as far as it went, also its success. Not a drop of blood was lost after it. That the patient died from intermittent fever running into the continued form, and that of the typhoid type (induced probably by loss of blood), no one who has observed the endemic disease of this climate will be inclined to doubt." Mr. Liston, in supporting the practice he pursued in the case of Mr. Seton by precedents, has adduced in a particular manner this one of Osten Cooper from my book (according to the report of the three weekly medical journals), and has erroneously attributed the above remarks to me; adding, after transcribing the last, "So says Mr. Guthrie, who it is to be presumed conducted the treatment of the patient." I do not object to Mr. Liston having made use of me in this way. I must be permitted, however, to say in my turn, that I never saw the man nor knew of the operation until the case was sent to me by the staff surgeon who did it. I published it in the midst of several cases showing the impropriety of such an operation, and in a part of my book in which it is said I criticised Baron Dupuytren rather sharply for recommending a similar practice. It is my duty, however, to express the great regret I feel at having so misled Mr. Liston by my negligence or by my delicacy towards my old friend the operator, as to have caused him to misconceive my meaning, and I consider myself justly liable to bear a large proportion of the blame of any evil which may have been occasioned by them. In thus acknowledging the error I unintentionally committed, I am the more bound on this occasion to make my meaning so plain that it cannot again be misconceived. I shall therefore say, that if this man, Osten Cooper, had not died of fever, he would in all probability have died from a recurrence of the hemorrhage from the original wound, in consequence of the right operation of tying the artery having been done in the wrong place, and where it could be of no use unless by accident.

On the peace of 1814 being made, I was placed on half pay, with a month's notice to quit, somewhat like a turned-off footman, and was obliged to seek for other employment. The hundred days of Napoleon found me trying to establish myself in London. I had placed my all on the hazard of that cast, and I was obliged to await the result. Three general officers, high in rank, requested me to accompany them on service, and to live with them during the campaign of Waterloo. My old and kind friend Sir James M'Grigor, then just appointed director general, offered to place me on full pay for six months; I would willingly have served for three, but that would have been thought a job,—that the service had been made use of to favour my views. I therefore went to Brussels and to Antwerp, like other amateurs, without rank, pay, or any appointment. The whole of the medical officers received me as no other person had ever been received: they all said, we know your object, and everything we have in our charge is at your disposal; we will do everything you wish, and do you what you please. I visited the severest cases only. There was not a mother, wife, or sister of a badly wounded officer at Brussels whose knees were not bent to me, not a father or a brother whose hat was not off and down to the ground. I was as poor as a rat in those days, but my opinion was not to be purchased; no one presumed to think of such a thing; now that I am not so poor a man, and my opinion may be more valuable, every one thinks he does me a favour who gives me one or two guineas for it. Perhaps it may be so. I was then however more gratified in working for nothing than I now am for money. All the senior officers of hospitals offered to send to London any of their bad cases that I could obtain permission to bring over. I did two operations only at Brussels and none at Antwerp. One an amputation at the hip-joint, the second the operation related in Case No. 50, and a third man was sent after me, who had a ball rolling about in his bladder, whom I afterwards operated on successfully in the York Hospital, Chelsea. A large body of military and medical staff officers were present to see me remove the ball, which had become encrusted and formed a stone. The Duke of York visited this man, and took so great an interest in him, a German, and in the Frenchman

whose thigh I had amputated at the hip-joint, as to obtain for both pensions, and for the latter a place in the Hotel des Invalides in Paris, where he was for many years the only living instance of a successful operation of the kind. Two large clinical wards were given to me, on my return from Brussels, by Sir James M'Grigor, for two years, on the same terms, viz., that I did the duty without any remuneration whatever. These were filled with the worst and most interesting cases my friends could send to me, not only from Brussels and Antwerp, but latterly from Harwich, Colchester, and Chatham. They were given for the purpose of enabling me to deliver those lectures to the officers of the public service with advantage, which I continued for five-and-twenty years, and of which those I am now giving are only a continuation. It will now be readily understood why I could not publicly find fault with any of the gentlemen who had behaved so kindly to me, and particularly with the surgeon of Osten Cooper; and you will observe in these lectures, that wherever I have not approved of the practice pursued in any case by my contemporaries, I have rarely named the surgeon in charge of it. I want merely the fact for the benefit of science, not the inculpation of an individual.

If, under these circumstances, I sometimes address you more dictatorially and magisterially than may appear befitting, I will beg of you to bear in mind that on many of the points in question I have had greater opportunities of acquiring information than most persons now living, and I may be permitted to add the expression of my regret that I should have made comparatively so little use of them. On many of the great occasions to which I have alluded, there was scarcely time for a remark, much less for written notes to assist the recollection.

I have given you this slight sketch of things long since passed away, that you and others whom I sometimes annoy by my representations, may be aware why I interest myself on all occasions in favour of the wounded soldier, his medical attendants, and the reputation of the surgery of the public service; that you may also know that all the favour which ever has been shown me has been to give me opportunities for good hard work, and for which I was then thankful and am now grateful. With respect to advancement, emolument, or rank, I hold the same rank and station and have the same half pay I was entitled to in 1812, when I had the charge of two-thirds of the British army under Lord Hill opposed to Marshal Soult in front of Madrid.

Case 91.—Dr. Buchanan relates the case of a boy in the 5th vol. of the *Glasgow Medical Journal* for 1832, p. 151, who suffered from hemorrhage, which caused him to do the operations of tying the femoral, inguinal, and external iliac arteries. The boy had been injured on the 15th January by the wheels of a rail-waggon, which caused a mortification of the skin and subjacent tissues of the upper part of both thighs, and of the lower part of the abdomen. The ulceration left on the separation of the sloughs contracted into a deep unhealthy looking hollow in the left groin, which had partly filled up, and he was gradually becoming convalescent, until eighteen days after the accident, when hemorrhage to the alarming extent of thirty ounces took place, and only stopped on the boy's fainting. A coagulum formed over the part whence the blood came, and the femoral artery could be felt immediately below it in the hollow alluded to. From the state of great depression into which he fell he had gradually recovered during the three subsequent days, when a second bleeding took place to the extent of a pound, issuing from a small aneurismal pouch, about the size of a field bean, in the centre of the soft flabby ulcerated hollow in the left groin. The hemorrhage was restrained by compression with the finger on this spot, and all operative process was deferred in consequence of the great state of exhaustion of the patient, from which he again recovered. Nine days afterwards a slight bleeding recurred, and was easily arrested.

On the 26th of February, or forty-two days after the accident, bleeding again took place to the amount of two ounces, and was arrested by compression with the finger. The wound being minutely examined in consultation, the compress was removed, and a gush of arterial blood followed, which was at once stopped by the finger. It appeared to come from the femoral artery, which, with its sheath situated in the hollow before referred to in the groin, seemed to be in a soft and friable state. The external iliac artery was then secured by ligature, and the bleeding ceased. No pulsation could be felt next day in the left femoral or popliteal artery. Four days after the operation, or on the 2nd March, at seven in the morning, bleeding again took place from the same spot as before to the extent of an ounce, the patient stopping it himself, although it returned at two different periods before two o'clock on attempting to remove the finger from the hemorrhagic spot. Suppression of bleeding and pulsation was effected by compression of the femoral artery on the distal side of the place whence blood issued. The femoral artery below was tied, but in vain, for the hemorrhage recurred with equal violence on the removal of the compression made by the finger over the bleeding spot. It was then thought right to place a single silk thread ligature on the inguinal artery immediately above the bleeding point, underneath Poupart's ligament, on tightening which the pulsation and hemorrhage were instantly arrested. On the 6th, or four days after this operation, pulsation could be detected in the popliteal artery. On the 15th the boy died from exhaustion, the effect of a large abscess on the ilium and sacrum, the surgical wounds being nearly healed. The ligatures on the femoral and inguinal artery, applied on the 2nd of March, came away on the 12th.

Remarks.—The ligature on the external iliac was useless, and should not have been applied, as it did not prevent the collateral branches, and principally

the epigastric and circumflexa ilii arteries, from restoring the hemorrhage through the inguinal, the ligature on which alone was really efficient, and ought to have been applied in the first instance. The ligature below the wound in the femoral artery would in all probability have become necessary, even if this had been done. This case is one of the best possible proofs of the soundness of the principle that a wounded or injured and bleeding artery is to be tied *immediately* above and below the seat of injury, and not at such a distance as admits, as in this case, of intervening branches restoring the circulation.

Case 95.—A gentleman received an injury in the upper part of the left thigh, parallel to, but some little distance below Poupart's ligament, from having ridden against the shaft of a van. The late Messrs. Heaviside, Howship, and Chevalier were sent for immediately, and my assistance was desired next morning. I called the attention of these gentlemen to the tallowy-white and mottled appearance of the foot and lower part of the leg, as indicating the loss of life from a deficient supply of blood, and assured them that the femoral artery, and probably the vein, were injured. In the mortification they would not believe, until it became too obvious as a case of dry white gangrene, the foot and leg shrinking and drying, whilst the course of each of the tendons on the instep and toes was marked by so many dark red lines. Amputation of the mortified part they would not hear of; they thought me (it happened many years ago) remarkably wild in my ideas, and as I was only a consultant, I yielded. On the eighteenth day after the accident blood flowed from the wound in an alarming quantity, and of a dark venous colour. This I pronounced to come from the lower end of the artery. My friends thought me a little more wild than before, and as the wound was so near Poupart's ligament, they proceeded, in spite of all my remonstrances, to tie the external iliac artery, which did not stop the bleeding. As I had predicted that it would not do so, they now began to think I did know something about the matter, and desired me to do what I pleased. I therefore enlarged the original wound in the thigh, sought for the lower end of the artery, which the dark flowing blood readily pointed out, and secured it by the ligature. The bleeding ceased, but the man died exhausted some days afterwards.

Remarks.—This is a remarkable case, and which I did not think it right to make known in its details during the lifetime of either of the surgeons concerned. There were nothing but errors committed in its management, simply because my colleagues knew little or nothing about the matter. They had not seen anything of the kind. Mr. Heaviside was too old to yield. Messrs. Howship and Chevalier were incredulous, and I was then too young to command that confidence which my knowledge authorised. The operation which ought to have been done on this man was to have enlarged the wound, and have tied the femoral artery at the lower part, from which it bled. The upper end would in all probability have given no trouble, and it would have been easily secured, if it had. The theory of aneurism, and the desire to do an operation then rather uncommon led to the ligature of the external iliac, and so signal an exposure of the failure of the theory, and its inapplicability in such cases ought to be convincing, whilst the propriety of, and actual necessity for, seeking for the divided and bleeding artery are made equally manifest. The remaining surgical point is yet, although near thirty years have passed away, of more importance still. The essential surgical question to be asked is, what ought to have been done with respect to the mortified limb? The followers of Mr. Hunter, as well as most modern surgeons will say, wait for the formation of a line of separation, and then amputate the leg. My reply is that the man did not live long enough to see that day, and that in such cases men never will live long enough for it to take place, and that as early an amputation as the recognition of the mortification will permit should be had recourse to. A more important question yet remains. At what part ought the limb to have been amputated in this case, and in other cases of a similar nature?

In Case No. 24, or that of Turnbull, I desired the limb to be cut off below the knee. I should have done the same in this case. The principle on which it is done I have pointed out in my work on Gunshot Wounds, with reference to the distinction between constitutional and local mortification. The mortification in both these cases was for the first two or three days almost entirely local, and the amputation would have succeeded at that time, before the constitution became implicated. By doing it below the knee, that joint would have been saved, and the collateral circulation would have been sufficient to preserve the life of the thigh between the knee and the wounded part of the artery, the profunda femoris being intact. It may be said that a greater security would be obtained by amputating the thigh at the wound, and this would be the best mode of proceeding if amputations so high up were not generally unsuccessful.

Case 96.—In this case, published by Mr. Norman in the 10th vol. of the Medico-Chirurgical Transactions for 1819, John Lacey, a boy fourteen years of age, was wounded on the 21st of August by a pitchfork on the upper and outer part of the thigh, which bled profusely at the time, and slightly on several occasions afterwards, until the 29th of September, when the bleeding was so profuse that it was thought right to endeavour to find the bleeding artery. An incision seven inches long was made, but the artery could not be discovered on removing the coagula, although an immense flow of blood followed their removal. As pressure on the groin arrested the hemorrhage, when the hand was passed into the cavity which had been laid open, and the finger within it reached the spot where the assistant compressed the artery in the groin, Mr. Norman tied the external iliac artery. This did not stop although it diminished the bleeding, and Mr. Norman therefore tied the femoral artery below Poupart's liga-

ment, and completely and finally arrested the hemorrhage. This boy at last recovered with the loss of his leg from mortification, which appeared six days after tying the external iliac; the limb was amputated above the knee.

Remarks.—Mr. Norman says plainly that the hemorrhage was arrested by the ligature below Poupart's ligament, and not by that on the iliac, which was therefore useless, and by giving rise to the mortification placed the boy's life in the greatest jeopardy. The amputation above the knee, and not as high up in the thigh as the wound, is the crowning point of this remarkable and most conclusive case.

Case 97.—M. Lutens (*Gazette Médicale*, 1842) placed a ligature on the external iliac artery in consequence of a wound of the femoral artery, some lines below Poupart's ligament, which had bled several times. The ligature having been applied during hemorrhage, the compress on the bleeding part was taken off as soon as it was tightened, when the hemorrhage returned as furiously as before, on which a second ligature was placed on the external iliac higher up, which failed equally in arresting the bleeding. It was now manifest that the epigastric and circumflexa ilii arteries poured their blood into the open femoral artery by regurgitation, and that the extremity of this vessel must be secured. To do this M. Lutens laid open the diffused aneurismal swelling, and after overcoming great difficulties tied the femoral artery below the origin of the profunda. A stream of blood still flowed from the wound, but was stopped by cold water. Mortification of the leg followed these operations, and the man died. On dissection it was found that the first and second ligatures were placed above the origin of the epigastric and circumflexa ilii arteries. The last was placed below the profunda, so that three vessels entered into the artery between the ligatures, and brought blood collaterally into it, two above and one below the opening made by the point of the sword.

Remarks.—It was utterly impossible for either of these ligatures to have suppressed the hemorrhage, unless these three communicating branches should have failed to bring blood into the main trunk from their collateral communications—a result which no educated men can reasonably have a right to expect. This case proves, in an incontrovertible manner the impropriety in the first instance, of placing a ligature on a wounded artery anywhere else than on the wounded part.

Case 98.—Bonnet was struck in a quarrel by a knife in the lower part of the upper third of the thigh, which was in vain attempted to be arrested by compression, under which a large diffused aneurismal tumour formed. The femoral artery was tied immediately below Poupart's ligament. Twenty-seven days afterwards, and seven days after the ligature had been detached, the patient walked down stairs, and brought on a bleeding, which was stopped by compression, but returned on the third day. Again arrested by the tourniquet, it returned two days afterwards. The surgeon then decided upon tying the femoral artery above the origin of the profunda. In doing this he introduced his finger into the hole whence the bleeding came, and thus arrested the hemorrhage. Disappointed in finding the situation of the profunda, he proceeded to tie the external iliac. The bleeding was then finally restrained, and the patient recovered.

Remarks.—The first ligature was applied after the method of Anel, and above the profunda, through which it is possible blood was brought back into the wound. When the supply from the epigastric and circumflexa ilii arteries was cut off, the hemorrhage ceased. Accident alone prevented its renewal, for the bleeding would certainly have returned if the collateral vessels had been very active, whilst the life of the limb was greatly endangered by the supply of blood through them being cut off.

Case 99.—M. Jobert, in the Hospital St. Louis, at Paris, tied the femoral artery an inch below Poupart's ligament, and above the profunda for a wound in the femoral artery where it lies under the sartorius muscle, and had formed a diffused aneurism. On the seventeenth day the patient died after four hemorrhages from the end of the tied artery, proving the insufficiency of the distant ligature with such an intervening branch as the profunda femoris. —*Gazette Medicale*, 1839.

Case 100.—Dr. Placide Portal, of Palermo, removed some enlarged glands from the groin. Secondary hemorrhage followed, and the external iliac was tied above the epigastric artery. The third day the bleeding from the wound returned, and a ligature was made to surround the femoral artery and vein at the bleeding point. The bleeding ceased, but the man died of peritonitis and gangrene of the limb, caused by the useless operation on the external iliac artery.

Case 101.—A gentleman, thirty-nine years of age, struck his thigh with the end of a fowling piece between the upper and middle third parts, and two months afterwards perceived at this spot a small but strong pulsating swelling, which gradually increased in size. At the end of twelve months it extended from within an inch and a half of the crural arch to where the artery passes through the triceps muscle. It had an elevation of three inches, and could not be covered by two hands laid over it. A ligature was placed by Dr. Murray on the femoral artery, at about an inch below Poupart's ligament, on the 20th of September (the operation of Anel). During the first fortnight he suffered most distressingly from flatus in the intestines, which was only effectually relieved by the introduction of Dr. O'Beirne's tube into the rectum. On the fifteenth day after the operation violent hemorrhage took place, to the extent of three or four pounds, and he seemed to be about to die. A ligature was then placed on the external iliac artery, and the bleeding ceased, which it had indeed done under pressure upon the bleeding part before the ligature was actually tightened. On the fifteenth day after this second operation, on the 27th of September, bleed-

ing again took place to the amount of three pounds from the first wound made in the groin, from which it flowed, not by jerks, but in a continued uniform stream, although of a red colour, and was restrained by pressure made below on the side of the aneurism, showing that it came from the lower end of the vessel. Pressure by graduated compress was made upon this part, and steadily kept upon it by bandage; the bleeding did not return, and the patient ultimately recovered.

Remarks.—Dr. Murray acknowledges that the first bleeding came on, in all probability, from the same place as the second, and that the ligature on the external iliac artery was unnecessary, although he strongly recommends that the external iliac should be tied in such a case in the first instance, and being one of aneurism of twelve months' standing, after a blow which might cause disease in the artery to some distance, he is certainly right in his recommendation. If, instead of being a case of aneurism from a blow, it had been one of a wounded artery, or of a diffused aneurism communicating with a wounded artery and an open wound externally, tying the external iliac would have been of no use. Compression could not have been so readily made, and an operation for securing the vessel at the part injured must have been done. Would any surgeon with an open wound in his own femoral artery an inch and a half below Poupart's ligament feel satisfied with having his external iliac artery tied, trusting to pressure on the wound to prevent hemorrhage? He would fear that both ends of his femoral artery might bleed through the hole in the side of the vessel, and that a ligature would be ultimately necessary above and below it, proving that he had run the risk of the ligature on the external iliac artery for nothing.

Case 102.—T. Berger, aged forty-five, struck his groin with the end of a plank, and two months afterwards discovered a tumour the size of a hazelnut, about two inches below the crural arch. A year afterwards, having made a violent exertion, the swelling increased to the size of a hen's egg, and soon after became larger. Compression was employed in vain, and on the 16th of October Baron Dupuytren tied the external iliac artery. On the eighth day afterwards, the circulation was established in the limb, and pulsation was felt and seen in the tumour. On the ninth the swelling was diminishing in size, but the pulsations were more distinct. On the twentieth day they were quite sensible to both touch and sight, and on the same day hemorrhage occurred from the wound. It was repeated on the second day, was arterial, and apparently from the lower end of the wound. The iliac artery was tied again higher up, and the pulsation in the tumour ceased for six days. It then returned, and it was plain that the blood which flowed did not come from the end of the artery which had been tied, but from vessels placed between the ligature and the ventral aorta; and what vessels, the Baron asks, could it be, unless it were the internal iliac and the internal mammary. By what trunk was it that the blood was conveyed to the aneurismal sac? The femoral artery presented no pulsation below the tumour, and compression appeared to increase rather than diminish it. Was it by the profunda? The position of this artery behind the tumour rendered it difficult to say. Was it, in fine, by the epigastric artery? The double communication of this vessel with the substernal and obturatrix is well known; nor is it a rare thing for a very considerable arterial branch to extend from one to the other of these arteries. This idea induced him, he says, to examine carefully the course of the epigastric artery, and it was with no small surprise that he felt strong pulsations along its course, even through the thickness of the abdominal parietes, and especially in the vicinity of the tumor. It seemed probable, therefore, that the epigastric artery was the principal agent in restoring the pulsations to the tumor, and that in this case, as it happens sometimes after tying the primitive carotid, the very facility of communication, so far from favouring the cure, was the cause of the reproduction of the disease. In the present instance, that facility had the additional inconvenience of giving rise to hemorrhage that might prove fatal.

Baron Dupuytren made compression above and below the wound; the former allowed blood to flow, the latter stopped it. The blood, therefore, he says, came from the lower and not the upper end of the artery. Graduated compresses and bandages were applied, five hemorrhages took place, and were suppressed between this and the thirty-sixth day, when the tumour, having apparently suppurated, was opened, and a quantity of sanious matter and thick pus was discharged. After this Berger went on well, and in two months was cured.

Remarks.—The collateral circulation restored the pulsation in the aneurismal sac on the sixth day. If there had been an open wound, Berger would have bled to death. If there had been a diffused aneurism with a hole or two in it, he would equally have bled to death. If the circulation had not been so restored as to enable the patient in such a case to bleed to death, he would have died of gangrene. Nothing can more clearly show the impropriety of placing a ligature on the external iliac artery for a wound of the femoral. This case was published in 1833, three years after the publication of my work, in which I have pronounced this operation to be inapplicable to a wounded artery, without a shut aneurismal-sac.

Case 103.—Sir C. Bell, in a lecture delivered at the Middlesex Hospital on the 20th December, 1834, made the following statement:—A man was wounded in the artery of the groin, and stopped the bleeding by holding the cut parts together until the surgeon arrived. He opened the wound, the man lost a quantity of blood, and fainted. The surgeon tied the artery, and went away. Hemorrhage recurred, and the man died. The surgeon was not aware, says Sir C. Bell, that the circulation is so free that the blood must flow by regurgitation where there is an open wound. A ligature must be ap-

plied first above and then below the wound in the artery.

Case 104.—William Bessct, a man whose constitution had been much injured by mercury, was admitted into hospital on the 1st of December, 1816, with an extensive, irritable, and sloughing bubo in the groin. On the 26th of the month, the external pudic artery, which was involved in the ulceration, burst, and discharged about a pint of blood, which was restrained by pressure; a second hemorrhage took place next day, and the ulceration spread still farther. On the 31st, the blood sprung from the artery in a full jet, when the actual cautery and pressure restrained it. On the 12th of January, the hemorrhage again returned, and was controlled by pressure. It continued to recur so often from this period, that the life of the patient was in imminent danger, until, on the 22nd, a dreadful discharge of blood threatened at once to terminate his existence. Constant pressure was now applied, and next day, on consultation, the parts were accurately examined, when, on removing the clots, it was found that the femoral artery itself had given way. No other resource then remained but tying the external iliac, which was accordiugly done. On the 24th the limb felt cold, and was insensible, except when firmly pressed upon. On the 25th the discoloration extended, a vesicle formed about the centre of the thigh, and a considerable quantity of coagula and sanies was removed from the groin. On the 1st of February, tension and pain of the abdomen came on, which was relieved by a dose of castor-oil. On the 2nd, vesication in various parts of the thigh began to establish itself. On the 9th, amputation was performed at a point close up to the trochanter, everything went on well afterwards, and the man perfectly recovered.—*Hennen's Military Surgery*, page 185, 2nd edition.

Remarks.—If the artery had been tied below or immediately under Poupart's ligament, so as not to have deprived the limb of the advantage of the collateral supply of blood from the epigastric and circumflexa ilii arteries, the man's limb might have been saved. The surgeon thought it safer for his operation not to interfere with diseased parts. Considering his operation *only*, he was right.

Case 105.—Dr. Warren of Boston, U.S.A., relates the following case in a recent communication to the Royal Medical and Chirurgical Society of London:—Amputation of the thigh was performed on account of disease in the condyles of the femur. Fifteen days after the operation hemorrhage occurred from a small artery near one of the angles of the stump, and at some distance from the ligature of the femoral, which still remained upon the artery. The parts were in a great measure united, so that it would have been extremely difficult to discover the bleeding vessel by dividing the recently united parts, and this was the only way it could be done. The patient being in a sinking state from the loss of blood, the femoral artery was tied four inches from the stump. The bleeding was arrested, but only for a week; it then returned from the same spot. The femoral artery was again tied at the distance of an inch below Poupart's ligament, care being taken to ascertain that the profunda was not immediately above the ligature. There was no return of the hemorrhage, and the patient became in a short time perfectly well.

Remarks.—According to my principles an incision should have been made on the anterior surface of the thigh through the parts down to the bleeding end of the artery, and a ligature should have been applied in sound parts, perhaps an inch above it, no branch intervening. The case is highly valuable, as showing how readily the profunda can maintain a hemorrhage, and how safely the femoral may be tied above its origin when sound. It may also be observed, that, although the last operation did succeed, it would have failed if the collateral vessels had been as entire as in Case 102 or 109.

Case 106.—A man, past the middle age, was sent to the Westminster Hospital by me in consequence of a large aneurism at the lower half of the thigh having been opened by mistake. The incision was too large to give hope of its healing, a large quantity of blood had been lost, and it appeared advisable as the case was so clear, to do something which might prevent a return of the hemorrhage. As this was an aneurism from disease of the artery, it was useless tying it at the wounded part. If the artery were secured at the usual place, it was probable that bleeding would occur from the open sac, and from the lower end of the artery, and seeking for that vessel in its passage into the ham, was likely to terminate badly. On consultation with Mr. White we decided on amputating the limb as giving the man the most certain chance of preserving life. It failed, however, of success, the man sinking after a few days from the defect of constitution, which had led us to prefer amputation as the least injury that could then befal him.

I had some regret after his death that I had not tied the femoral artery in the usual place, and stitched up the incision, covering it over with sticking plaster, compress, and bandage, so as to form a temporary barrier at least against bleeding, and thereby gain a little time, awaiting events. In the following case I practised it, but not with a more successful result:—

Case 107.—William Oakley, aged twenty-seven, admitted into the Westminster Hospital, September 10th, 1831, with an aneurismal swelling six inches in diameter, three above the level of the surrounding parts, the apex three inches below Poupart's ligament on the left thigh. The apex had been opened by mistake, and about four pints of blood had escaped. The complaint was at least of three months' standing. The external iliac artery was tied by me next morning, the 11th, and the man died on the 13th from gangrene of the extremity. Four ounces of fluid mixed with flocculi of lymph were found in the abdomen, the peritoneum being slightly inflamed for four inches around the incision, but being itself unhurt; the

iliac artery was properly secured. The aneurismal sac contained eighteen ounces of coagulated grumous blood besides the layers adhering to the wall of the sac, which extended upwards under Poupart's ligament, in a line with the inside of the ilium.

Remarks.—The extension of the sac under Poupart's ligament rendered this operation difficult; and induced me in my subsequent ones to make the first incision more parallel to the ilium on the anterior part of the abdomen, which much facilitates the operation, enables the operator to tie the artery as high as he pleases, causes less disturbance to the peritoneum, and lessens thereby the chance of peritoneal inflammation. I was not at that time aware of the advantages to be derived from friction applied to the leg and foot in preventing gangrene, but tried everything else usually recommended, and failed, the man dying of mortification of the limb, and of peritonitis.

In the clinical remarks I made on this case, and which I did not know were published in the *Medical Gazette* for October, 1831, until I met with them lately, I drew attention to the fact that when an aneurism bursts, or when a spurious aneurism forms from a wound, the pulsation is not only seen, but the noise made by the blood against the edges of the cut or ruptured artery is peculiar, unless obscured by the great quantity of coagula formed after extravasation. It is worthy of remembrance.

Case 108.—A young man was some time afterwards admitted into the Westminster Hospital with a femoral aneurism extending so much under Poupart's ligament as to cause me to believe I should be obliged to place the ligature on the common iliac, and I performed the operation accordingly. I found, however, that I could conveniently apply the ligature (a single thread of strong dentists' silk) a little below its division into external and internal iliac arteries, at which spot it appeared to be sound on being brought into view by turning the peritoneum containing the intestines to the opposite side. Major Fancourt, then an M.P., was present, and he told me on leaving the hospital that the late Mr. Lynn thought the operation so dangerous, that when it was over he said to him, "There, Sir, you have now seen a man killed in a right surgical manner." It was in this case I first tried friction to the foot and leg kept up for hours. It was successful in preventing mortification, and the patient rapidly recovered. He died some eight years afterwards of disease unconnected with his aneurism, and Mr. Canton, of the Charing-cross Hospital, who assisted in the dissection, has favoured me with the account of the distribution of the collateral vessels.

"The ligature had been placed round the external iliac artery at a part almost immediately below where it passes from the common trunk. From this point to near Poupart's ligament the vessel was much contracted, and reduced to the condition of a dense, fibrous-looking, impervious cord, of about the size of a crow-quill, though more irregular in outline than it. The most contracted spot was where the artery had been tied.

"From where the deep circumflexa ilii and epigastric vessels are given off, the external iliac was found to be pervious, and of about its natural size. The above-named branches, together with the iliolumbar were somewhat larger, and more tortuous than usual. The glutæal and obturatrix arteries were of more than twice their natural size, and as much curved as the splenic. The ischiatic was enlarged, but not proportionally so much as the two former ones. All the *chief* anastomatic communications of these vessels, as the circumflex arteries from the deep femoral, &c., were increased in calibre, whilst the small subsidiary inosculating branches in the neighbourhood of the operation, as the superficial epigastric, circumflexa ilii, muscular twigs, &c., were of the ordinary magnitude.

"The most remarkable permanent enlargement in the vicinity was that of the little vessel pursuing a somewhat parallel course to the femoral trunk; the "comes nervi ischiatici" was about thrice as large as usual, and in its passage to the knee communicated with muscular branches, offsets from the perforating arteries, and in the ham, with some minor ramifications of the articular and muscular branches from the popliteal. The comes nervi ischiatici was so tortuous in its whole course that the convexities of the numerous curves almost touched one another."

Case 109.—Dr. Horner, of the University of Pennsylvania, placed a ligature on the external iliac artery, just above the origin of the epigastric artery, in consequence of an aneurism of the femoral in the groin, extending under Poupart's ligament, especially on its outer side. This operation having been completed with great precision, as was proved after death, Dr. Horner thought it right to open the aneurismal sac, which, after the laminated fibres and coagula had been removed, poured out arterial blood in the most formidable and urgent manner, so that the patient lost more than twenty ounces in a few minutes. The sac was further laid open, in doing which the femoral artery below was cut through, and both ends were immediately secured by ligature. This in part arrested the bleeding, but did not suppress it. It was then found that the upper end of the femoral artery coming into the superior part of the sac was pouring out blood; this was also tied. The bleeding then ceased, and as no bleeding orifice could be discovered on the inner surface of the sac, another ligature was placed on the femoral artery above the last by way of precaution. The man died exhausted, but without further bleeding, on the sixth day. Dissection showed inflammation and suppuration behind the peritoneum and the external iliac artery, up to and behind the right kidney. On examination of the aneurismal parts it was found that "an orifice of an inch in length existed on the iliac side of the femoral artery, that the sac itself was formed almost entirely by the contiguous cellular substance of the inguinal and iliac margins

of the cavity of the sac. The profunda artery arose at or near the aneurismal orifice; the precise point," Dr. Horner says, "I did not ascertain, but I believe very close to its upper end; we may therefore conclude that the retrograde hemorrhage came from the anastomosing of its branches with those of the internal iliac artery, and also from the epigastric and circumflexa iliac judging from the incidents of the operation."

Remarks.—If Dr. Horner had been contented with his first operation he might perhaps have succeeded better. By opening the aneurismal sac he brought it into the state of a wounded artery, into which the collateral circulation readily brought blood, and he had to treat it as a wounded artery with the disadvantage of its being also a diseased one. It is an admirable case to prove the impropriety of treating a wounded artery communicating with an external opening by the operation for aneurism, done at a distance; for the bleeding must recur, as it has been shown to have done in almost every instance which has been adduced.

Case 110.—Col. F., aged thirty, of a powerful habit, was wounded by a small pistol ball, April 15, 1837, which entered the left thigh two inches below and a little within the anterior superior spinous process of the ilium, and ranging very nearly in line with Poupart's ligament, came out on the inner side of the thigh a little below the scrotum. It was followed by a profuse hemorrhage estimated at several pints; the patient fainted and remained insensible until next day; from this state he recovered, and in July a strongly pulsating tumour was felt just below Poupart's ligament in the course of the femoral vessels, which had the thrill and vibratory motion of varicose aneurism, with a loud, quick purring noise like that of a cat. A very strong pulsation was felt in the epigastric region; a feeble wavy pulsation was discernible in the opposite femoral vein at Poupart's ligament, as if arising from the arterial blood passing from the left femoral artery into the left femoral vein, and upwards to the vena cava, whence it was communicated downwards. Dr. Horner, satisfied that all varicose aneurisms should be operated upon at the part injured, tied the femoral artery on the 10th of the month, immediately below Poupart's ligament, and all pulsation ceased. On the 14th, mortification of the leg was evident, and eventually extended up to the tumour on the thigh. On the 26th the thigh was cut off through the mortified part. On the 2nd of August, twenty-two days after the operation, the ligature from the femoral artery was cut away. On the 3rd a small white and very sensible tumour, without pulsation, in the situation of the extremity of the artery was punctured; and a flow of blood took place, which pressure on the artery above did not suppress. This tumour, which proved on further investigation to be aneurismal, and of new growth, was cut off by various ligatures applied around it, when the bleeding ceased, showing that in all probability the hemorrhage had come from a retrograde instead of a downward current of blood, and which was proved to be the case after death. Twenty-eight days after the first operation, the parts included in the last ligature looked black and dead, and with the aneurismal tumour ready to drop off; the patient looked like a breathing corpse, but he did not die until four days after.

It was found on examination after death that the upper part of the femoral artery was firmly closed at its cut extremity for a line in thickness, having a conical coagulum of bloody fibrin adhering to it, about three lines in length, with the apex upwards. The lower part of the artery was separated from the upper at the part where the ligature had been applied; the canal of the artery put on the appearance of a dilatation; was thickened and pervious to its end. The femoral vein was open from below upwards, and exhibited signs of being inflamed as high as the ascending cava—a certain cause of death.

Dr. Horner supposes that mortification took place from the blood of the collateral circulation pushing its way into the femoral vein instead of descending to the foot, and he inquires whether the collateral branches should not if possible be enlarged before an operation for aneurism is performed.

Case 111.—Dr. Brainert, of the University of St. Louis, was called to a gentleman of Chicago, in Illinois, U. S., who had fractured the neck of the femur twelve weeks before, and which had not united. For twelve months after this he wore a starch immoveable bandage, when an aneurismal tumour was perceived at the upper part of the thigh under Poupart's ligament, and which he had seen for twelve weeks. The external iliac was tied, and the patient recovered, the tumor subsiding very slowly under pressure. The bone remained ununited. This was in all probability an aneurism formed from the broken bone having injured the artery some time before it took place.

Case 112.—Mr. Bransby Cooper in his Surgical Essays, page 79, relates the case of R. Weaver, who had suffered a compound, but not comminuted, fracture of the lower third of the femur, on the 5th of February, the opening in the integuments being a small laceration, over which a piece of lint was placed. On the 9th a diffused swelling in the ham was first perceived, evidently aneurismal. The femoral artery was tied in the usual place above the fracture, and the man recovered. Mr. Cooper observes, "With respect to securing the vessel, the surgeon would be guided in such a case by the situation of the external wound; for had the wound in this case been in such a situation as to admit the escape of the diffused blood, I consider the case would have been entirely altered, and that the limb must have been amputated, or else the wounded artery tied above and below the opening, which in the popliteal space could hardly be accomplished; but as the blood did not escape, the coagulum was capable of forming so firm a compression upon the wounded vessel, that upon the application of a ligature above there was no fear of the recurrence of the hemorrhage.

Remarks.—I concur in opinion with Mr. Cooper, and in the practice pursued, as the wound in the artery did not communicate with the external opening. If it had done so from the first, it would have been a question of amputation. In a healthy man I should have preferred, in the first instance, tying both ends of the wounded artery, and awaiting events, watching carefully the approach of mortification, for the purpose of removing the limb at the earliest possible moment.

LECTURE VI.

No operation should be done on a wounded artery unless it bleed at the time when the ligature is applied; Case of musket-shot wound at the upper part of the thigh; Repeated occurrence of secondary hemorrhage arrested by pressure on the main trunk; Cure without operation; Remarks on the case; Baron Larrey's case of sword-wound on the upper and anterior part of the thigh; Severe consecutive hemorrhage; Formation of a false aneurism; Cure by bleeding, and the local application of ice; Mr. Porter's case of wound of the profunda artery with a knife; Consecutive hemorrhage; Cure without operation; Mr. Cock's case of wound of the superficial femoral artery; Operation for exposing and tying the wounded vessel, the great depth preventing the application of the ligature; Success of pressure by a piece of sponge passed down to the bottom of the wound, and the application of a ligature on the femoral artery about the middle of the thigh; Case of wound of the upper part of the thigh by a duck-shot; Repeated hemorrhage; Formation of a diffused aneurism, opened in error; recurrence of hemorrhage; ligature of the femoral artery high up; Repeated hemorrhages terminating fatally; Remarks on the case; Case of wound in the upper part of the thigh; Occurrence of severe hemorrhage; Formation of a false aneurism; Ligature of the external iliac artery; Death from peritonitis; Post-mortem appearances; Case of wound of the arm-pit; Repeated secondary hemorrhages; pressure on the subclavian ineffectual; The bleeding arrested by enlarging the wound, and the application of pressure directly on the bleeding aperture in the artery; Ligature of the subclavian above the clavicle; Return of the hemorrhage from the arm-pit, and subsequent hemorrhage from the wound of the operation; Ligature of the innominata; Death of the patient in ten hours; Post-mortem appearances; the axillary artery uninjured, the inferior thoracic completely cut across; Comments of the editor of the Lancet on this case; this case a parallel one with that immediately preceding, and the editorial remarks equally applicable to both; Comments on these cases, with the requisite surgical treatment, and the operations which were performed objected to, and condemned.

There is no point more important than that to which I must now *especially* call your attention. It is that no operation should be done on a wounded artery unless it bleeds, inasmuch as hemorrhage once arrested may not be renewed, in which case any operation must be unnecessary. The first case to which I shall refer shows how firmly the principles on which wounded arteries ought to be treated, were fixed in my mind in the year 1812; and if there is one case to which I look back with more satisfaction than another, during that eventful period, it is the following.

Case 113.—John Wilson, of the 23rd regiment, was wounded at the battle of Salamanca by a musket ball, which entered immediately behind the trochanter major, passed downwards, forwards, and inwards, and came out on the inside of the anterior part of the thigh. The ball could not have injured the femoral artery, although it might readily have divided some branch of the profunda. Several days after the receipt of the injury, I saw this man sitting at night on his bed, which was on the floor, with his leg bent and out of it, another holding a candle, and a third catching the blood which flowed from the wound, and which had half filled a large pewter basin. They seemed to think it would stop in due time, having bled once before during the afternoon. I placed a tourniquet with a thick pad as high as possible on the upper part of the thigh, and requested the officer on duty to loosen it in the course of an hour, which was done, and the bleeding did not recommence. The next day I placed the patient on the operation table, removed the coagula from both openings, and tried to bring on the bleeding by pressure and by moving the limb; it would not however bleed. As there could be no other guide to the wounded artery, which was evidently a deep-seated one, I did not like to cut down into the thigh without it, and the man was replaced in bed, and a loose precautionary tourniquet applied. At night the wound bled smartly again, and the blood was evidently arterial. It was soon arrested by pressure. The next day I placed him on the operating table again, but the artery would not bleed. This occurred a third time, and with the same result. The bleedings were however now almost immediately suppressed, whenever they took place, by the orderly who attended upon him; care having been taken to have a long thick pad always lying over the femoral artery, from and below Poupart's ligament, upon which he made pressure with his hand for a short time. The hemorrhage at last ceased without further interference, and the man recovered.

This ease was to me of considerable interest, more particularly because I had not decided in my own mind what operation should be done. I did not like to place a ligature on the femoral artery above the profunda, neither was I satisfied with the idea of tying the profunda an inch below its origin. It was on this account that I was desirous that the wound should bleed at the moment of operating, as my finger introdueed into it might lead to the spot whenee the blood flowed, whilst I might also be guided in forming my opinion, by the manner in, and plaee at whieh pressure eaused it to cease. I might have tied the profunda, but I certainly would not have tied the superficial femoral artery. My intention was however to aseertain if possible whether the wounded artery would be more easily got at by a transverse ineision on the fore or baek part of the thigh, and to proeeed aeeordingly. In a similar ease I should introduee my finger into the wound, and enlarge it transversely, continuing the ineision until the opening was suffieiently large to see to the bottom of the wound or the bleeding part. It is neecssary to be attentive to the eourse of the great vessels and nerves, but not to the safety of museular fibres, the division of whieh leads to no permanent injury. I am aware, that as pressure on the main trunk led to the ultimate suppression of the hemorrhage, it may be said, that a ligature placed high up on the femoral artery would not only have done the same, but would have relieved the man from the anxiety neeessarily dependent on the momentary fear of a recurrenee of the hemorrhage. There are two objections to this method of proceeding: the likelihood of mortifieation taking plaee, which I have suffieiently shown to be in similar eases a probable occurrence; and the possibility of the hemorrhage being renewed through the anastomosing braneches. The temporary suspension of the circulation by pressure does little or no harm, more particularly where the pad used is so thick as to cause it to fall principally on the artery, and only in a slight degree on the surrounding parts, whieh by a little attention may be readily aeeomplished. I have succeeded in many instances of hemorrhage from less important places, by proceeding in this manner; but I have selected this particular ease as an example to ground the proper line of praetiee upon, because it was of more importanee than most of those whieh usually fall under the observation of the surgeon. It is not good practiee to cut down upon an artery on the first occurrence of hemorrhage, unless it be so severe or so well marked as to leave no doubt of its being from the main trunk of the vessel itself; nor is it then advisable to do so except the artery continue to bleed; for many a hemorrhage, supposed to have taken place from the main trunk of an artery, has been permanently stopped by a moderately continued pressure exercised in the eourse of the vessel, and sometimes on the bleeding part itself, particularly if the blood be of a dark colour, indieating that it comes from the lower end of the vessel.

Remarks.—This ease was printed with the preceding annotations on it, in 1830, in my work on the Diseases and Injuries of Arteries. It shows that the praetiee I now inculeate is not that of this day, and I am particularly desirous that this faet should not be overlooked. It is my apology and my authority for eondemning an opposite practice in my eotemporaries.

A painter eould not have had a better subjeet for a pieture illustrative of the miseries which follow a great battle, than some of the hospitals at Salamanca at one time presented. Conceive this poor man, late at night, in the midst of others, some more seriously injured than himself, calmly watching his blood—his life flowing away without hope of relief, one man holding a lighted eandle in his hand, to look at it, and another a pewter wash-hand basin to prevent its running over the floor, until life should be extinet. The unfortunate wreteh next him with a broken thigh; the ends lying nearly at right angles, for want of a proper splint to keep them straight, is praying for amputation or for death. The miserable being on the other side has lost his thigh; it has been amputated. The stump is shaking with spasms; it has shifted off the wisp of straw whieh supported it. He is holding it with both hands in an agony of despair. You may think I am exaggerating; I assure you I am not, and I refrain at the present moment from saying much more, which however I shall tell you at some future day, that I may not attract your attention from our all-important subjeet.

Case 113.—D. Hyppolite was wounded on the 9th of April by the point of a sword on the superior, external, and a little on the anterior part of the right thigh, about three inches and a-half below the anterior inferior spine of the ilium, which penetrated to the depth of two inches and a-half in a horizontal direetion from without inwards, and a little baekwards, so as to injure, as was supposed, the external and back part of the femoral artery. The wound bled profusely by jets, until the man fainted, when it ceased, but was renewed next morning, and was arrested with the greatest difficulty. On the 11th, when admitted into the hospital of Gros Caillou under Baron Larrey, there was a pulsating swelling in the right groin of a slightly blue colour, the size of a man's fist, extending from the anterior inferior spine of the ilium to the pubes. He eomplained of a feeling of eold in the leg and foot of the affeeted side, and of great heat in the swelling. The pulse was hard, full, and vibrating. He was bled twice in the first twenty-four hours, had ieed barley-water to drink, and an antispasmodic nitrated emulsion at night. The leg was bent on the thigh, and the thigh on the pelvis, the patient being laid on his back in bed. A cold emollient poultiee was laid on the swelling, and the leg was wrapped up in hot flannel. These symptoms subsided by degrees, and after the third day pounded iee was added to the cataplasm. Under these means the inflammatory symptoms gradually yielded, the swelling diminished in size, and the pulsations beeame less strong. Ice contained in a

bladder was substituted for the iced poultice, and was frequently renewed, and continued without interruption. The circulation through the artery below, which had been at first arrested, was gradually restored by the collateral circulation, and the man recovered.

Remarks.—This case should be always in the recollection of surgeons, offering an example to be followed in all similar instances. Case 62, also by Baron Larrey, and Case 63, by Delpech, are instances so honourable to these gentlemen on the same point, that I cannot refrain from gratifying my own feelings by offering this homage, as it is expressed in France, to their memories.

Case 114, by Mr. Porter of Dublin.—A boy attempting some improper liberties with a female servant was struck by her with a knife on the superior part of the thigh, and the profunda artery was wounded. The bleeding was immediately controlled, but after nine days burst out again, welling forth without impetus, and coming from the inferior section of the artery. Pressure was applied, but ineffectually, for in a little time he bled again, and after several recurrences, it was proposed to tie the external iliac artery. On being placed on the table for that purpose, some one remarked that he had not bled since the previous evening. He was therefore replaced in bed, and never bled afterwards.

Remarks.—If the external iliac artery had been tied, the cure would have been attributed to it, and if mortification or peritonitis had supervened, it would have been said that they were unavoidable evils, and instead of applauding Mr. Porter's just decision, the invaluable example he set, and the sound knowledge of the proper treatment of wounded arteries he exhibited, I must have passed his case by without a favourable remark. If, unfortunately for the lad, the external iliac had been tied, and the bleding had recurred, Mr. Porter must, I presume, have tied the common iliac, and if that had not succeeded, the aorta, or he must have descended to the more simple operation of cutting down upon and tying the bleeding vessel, and thereby saving the patient's life, if not too late.

Case 115, by Mr. Cock of Guy's Hospital.—H. P., aged twenty-six, a butcher, healthy, and of temperate habits, was admitted into Guy's Hospital under the care of Mr. Cock, on the 19th of October, 1844 (see 26th vol. of *Medical Gazette*). In dividing a calf's head his knife slipped, and entered his thigh on the inner side, near the junction of the middle and lower third, and penetrated to the extent of some inches. He lost a large quantity of blood, and became faint. Pressure, and the prompt application of a tourniquet, effectually prevented further hemorrhage. An hour after the accident, he was in a state of complete collapse, but sensible and collected. Below the tourniquet the thigh was distended with effused blood, and he complained of great pain and numbness of the whole extremity. On relaxing the tourniquet arterial blood flowed freely from the wound, which was about an inch in length, and extended transversely across the situation of the sartorius muscle, exposing the fascia beneath. The tourniquet placed over the femoral artery below the origin of the profunda, completely commanded the bleeding. The superficial femoral had sustained the injury, and it was determined to follow the track of the wound, if possible to the artery, and place a ligature above and below the opening in the vessel where injured. The tourniquet having been removed, and the artery commanded by pressure at the groin, a longitudinal incision was made in the direction of the femoral artery. The sartorius was found to be divided across, and retracted upwards to a considerable extent, the extremity presenting a large, rounded, bulbous appearance. On cutting through the fascia a large quantity of extravasated blood was brought into view, and no sooner was this disturbed and partially removed than a copious gush of dark coloured blood took place, and continued to flow freely, as was supposed, from a large vein. Mr. Cock then discovered that the wound had a direction downwards, to the extent of at least four inches into the popliteal space, and it appeared most probable that the vessels, both artery and vein were cut, as they emerged from the lower opening of the canal of the adductor magnus. The great depth of the wound, and the free venous hemorrhage, precluded the possibility of tying the artery at the seat of injury. The bleeding was first stopped by introducing a piece of sponge down to the bottom of the wound, and by exposing and placing a ligature on the femoral artery about the middle of the thigh. The bleeding, both arterial and venous, was then effectually arrested; the edges of the wound was brought together by suture and plaster, except at the lower part, where the sponge had been introduced. The limb was placed in an easy position, the leg and foot covered with flannel, and he took thirty drops of tinct. opii, brandy and water, &c., and passed a tolerable night. On the fourth day after the accident suppuration of a healthy character commenced; the sponge was subsequently removed, the edges of the wound were approximated, and supported by plaster, and he was ordered quinine with morphia at night, with a generous diet. The suppuration was extensive. The ligature came away on the fourteenth day; the cure was not however completed until the end of March.

Remarks.—There could be no doubt of the propriety of placing a ligature on the femoral artery immediately above where it was injured. If the femoral artery when exposed had been followed downwards, it is possible the dissection would have shown the wound in the artery, and that the venous blood flowed from the lower opening in it. The sponge thrust into the lower part of the wound acted as a compress, and as the collateral circulation is not established with much impulse in the first instance, the operation succeeded, and in a manner highly creditable to Mr. Cock. If the sponge had not been sufficient to prevent a recurrence of the hemorrhage, Mr. Cock would have been obliged to follow the

artery, if necessary, into the popliteal space. This might have been done by extending the incision in its length, or by making the finger protrude below over the artery, and then cutting down upon it. A Pouteau's or curved trocar and canula may be used in such cases with advantage as a director.

Case 116.—A young gentleman, aged twelve, accompanying his brothers shooting in December, 1844, was struck in the upper part of the left thigh by a duck-shot, which entered about three inches below Poupart's ligament, and a little to the inner side of the femoral artery. He bled until he fainted, and was taken home. There was no return of the bleeding for three days, during which time the limb was exceedingly painful, and soon began to enlarge. After this time occasional and considerable bleedings took place, the limb still continuing to enlarge. Fomentations and poultices were applied; irritative fever set in, and the pain was intense. At the end of a fortnight the small hole made by the shot appeared to be healed over by a thin skin of a blue colour, which tint extended for some distance. The limb was enormously swollen, with a feeling of distension, which induced the surgeon to puncture the most prominent part with a lancet. After some clots of blood had been removed, an alarming arterial hemorrhage took place. The femoral artery was now tied high up, below Poupart's ligament. The bleeding was in some measure restrained, but not suppressed, and after a short time returned at intervals with augmented violence, until death ensued, three weeks after the accident.

Remarks.—If an incision had been made into the thigh in the course of the wound when the bleeding returned on the third day, and both ends of the wounded artery had been tied, the boy would doubtlessly have recovered. The ligature placed on the femoral artery above the wound in it did restrain for a short time the flow of blood, but could not prevent its flowing from perhaps both ends of the vessel, until it destroyed the patient. A ligature on the external iliac would only have caused it to be deferred for a day or two, until the collateral branches had enlarged, or else he would have died of mortification. The case was a bad one from the moment the thigh began to be so greatly injected with blood, but the decision shown by Mr. Keate in Case 13, and by Mr. Norman in Case 96, might have saved his life, even almost unto the last. In this case it was exceedingly possible that the profunda was injured, and not the femoral artery, the tying of which or of the external iliac could not have done good for a permanency, as the bleeding would doubtlessly have returned on the establishment of the collateral circulation.

This really formidable case shows most distinctly the necessity for always observing the rule of tying the wounded artery at the part injured, in order that the mistake may not be made of placing a ligature on the wrong artery—the constriction of which may cost the patient his life, whilst it may not prevent a return of the bleeding. It also shows that no loss of blood from a diffused aneurism can equal the danger which must be encountered, and the mistakes which may be made, by not laying it open, and seeing the hole in the artery, or its divided extremities. These cases may be considered together with the greatest advantage, as indicating the principle of surgery to be pursued in all similar instances.

Case 117.—A short man, fat of his age, was wounded in the upper part of the right thigh, a little above and in front of the great trochanter, the wound being continued across the thigh, its internal opening being about the middle of the fold of the left or opposite groin. He lost a good deal of blood at the time, the issue of which ceased on his fainting. Ten days after the accident his countenance was blanched, his pulse rather quick and feeble. On examining the wounds, that on the right hip (the opening of entrance) was circular, filled with a dry, depressed slough, and there was a narrow, faint blush of redness round its margin. In the left groin the opening of exit was marked by a jagged slit, already partly closed by a thin cicatrix. There was extensive mottled purple discoloration (ecchymosis) of the skin in both groins, and over the pubes, scrotum, and upper part of the right thigh. In the right groin was found a large, oval, visibly pulsating tumor, its long diameter extending transversely from about an inch and a-half on the inner side of the anterior superior spinous process of the ilium to about opposite the linea alba, and its lower margin projecting slightly over Poupart's ligament into the upper and inner part of the thigh. On handling this tumor, it appeared elastic, but firm, very slightly tender, and not capable of any perceptible diminution in bulk by gradual and continued pressure. The pulsation was distinct at all parts of the swelling, and was equally evident whether the fingers were pressed directly backwards, or whether they were placed at its upper and lower margins, and pressed towards the base of the tumor, in a direction transversely to its long axis, the parts being for the time relaxed. The femoral artery was slightly covered by a swelling, and the pulsations of that vessel were with some difficulty distinguished in the upper third of the thigh, below the margin of the tumor. This appeared to depend partly on the natural obesity of the patient, and partly on a considerable degree of general swelling of this thigh. Pressure on the femoral artery or over the abdominal aorta did not arrest the pulsation in the tumor, and in the former situation was attended with severe pain. Under these circumstances it was deemed advisable to apply a ligature on the external iliac artery, and give the patient a chance of the occurrence of coagulation in the tumor, and closure of the wounded vessel, before the free re-establishment of the circulation through the femoral artery. In the present case, it was supposed that mortification of the limb was all the less likely to occur from the circumstance that the greater part of the effusion appeared in front of the abdominal parietes, and therefore exer-

cised less pressure on the femoral vein than if further extension into the thigh had taken place. The danger of peritonitis was by this proposal made a new element in the calculation; but it was estimated that the chances of this and mortification of the limb taken together were less unfavorable than the chances of immediate and secondary hemorrhage attaching to the operation of tying the artery at the spot injured. The operation being completed, the right foot, leg, and thigh were enveloped in lamb's-wool and flannel, and the limb elevated on an inclined plane of pillows, so as to favour the return of blood as much as possible, and prevent venous congestion. The day on which the operation was performed was passed in considerable pain, the patient being restless, and complaining of a sense of burning in the limb. An anodyne, however, secured him a tolerably good night's rest. The day after the limb was found altogether diminished in bulk, and its temperature equal to that of the healthy limb; no return of pulsation had taken place in the tumor. The same evening some tenderness and tension of the abdomen came on, though the bowels had been kept in a regular state by occasional small doses of castor-oil. In the morning of the second day, pain in the belly, with increased tension, hurried breathing, short dry cough, and tenderness over the lower part of the abdomen, were observed. Pulse quicker and small. Leeches were applied, and three grain doses of calomel, with a little Dover's powder, ordered every three hours. The symptoms however became rapidly worse; the patient complained of severe pain in the right leg, and a sensation of great heat over the whole body, although the actual temperature was rapidly falling below the natural standard. The right leg also became cold sooner than the left. At seven, p. m., he became more easy, and expressed an opinion that he should "do well;" but in little more than half an hour he expired.

Examination after Death.—Swelling and ecchymosis of the right thigh, particularly at the upper part, and in the right iliac region; also swelling and ecchymosis of the scrotum, chiefly in the right side, with general tumefaction of the abdominal parietes below the umbilicus. A wound into which the little finger could be passed was on the upper and outer aspect of the right thigh, about three inches below the crest of the ilium, and about an inch nearer the mesial line than the great trochanter, and on the left side another smaller wound situated about the external aperture of the left spermatic canal. The first-mentioned wound was open—the lips of the latter were partially adherent. The course of the wound was traced from the outside through a dense layer of fat about two inches in thickness (on an average). It had divided one of the superficial branches of the femoral artery, about half an inch below Poupart's ligament, and about an inch from the main body of the femoral artery, which had caused a false aneurism. The sac contained about three ounces of blood. Blood was also effused into the cellular structure of the scrotum, and downwards beneath the sartorius muscle. The wound passed through the cellular tissue, across the pubes, and emerged about the situation of the external spermatic ring, without having divided the cord on either side, and being quite superficial to the bladder. No other artery appeared to have been wounded. When the parietes of the abdomen were reflected, a considerable quantity of sero-purulent fluid was found in the abdominal cavity; and on different parts of the large and small intestines, patches of acute inflammation were observed, particularly on the ascending arch of the colon. The peritoneum adjoining the wound of the operation was inflamed, and approaching to gangrene; it had not been injured by the knife during the operation. The intestines were unusually large, and distended with flatus. The other abdominal viscera were healthy, but loaded to an extraordinary degree with fat. The ligature had been properly applied to the iliac artery; the vein was not injured; the surface of the wound and the cellular tissue in the neighbourhood of the artery were sloughy. There was some enlargement of the right limb, but apparently no mortification. The femoral artery was pervious; the course of the wound was through a bed of fat, fourteen inches in length, and three inches in depth, over the pubes, and no muscular substance was injured; the blood found in the aneurismal sac was firmly coagulated, and there was no mark of recent oozing from the injured artery.

Case 118.—N. Cormier, a soldier, with the army at Oran, in Algeria, received a wound in the hollow of the arm-pit from the point of a scissors mounted on the end of a stick, the flow of blood from which was arrested by some handkerchiefs bound tightly upon it. Four days afterwards a small bleeding took place, which was followed by three others during the subsequent eight days, all of which stopped spontaneously on removing the dressing. On the twelfth day he complained of great pain, which was attributed to the dressing not having been changed for four days; on removing them a jet of arterial blood followed, as large as a quill. Pressure was made on the subclavian artery, but it did not seem to be effectual, for as the blood was prevented from escaping by the external wound, the arm-pit became visibly more and more distended; the wound was therefore enlarged, when an assistant placed his finger on the bleeding hole in the artery and arrested the bleeding. The French surgeon then tied the subclavian artery above the clavicle, and prevented an immediate return of the hemorrhage.

On the sixth day after this operation the patient rose from his bed and walked across a yard, which gave rise to *bleeding from the arm-pit*. This was arrested by cold applications. During the night and the following day he lost more blood. Three days afterwards, or the ninth from the operation, the ligature on the subclavian artery was found loose in the wound, and the dressing was saturated with blood, the discharge being fetid. This wound bled

three times during the evening, and at twelve at night the surgeon placed a ligature on the arteria innominata (*le tronc brachio-cephalique*).

The patient died ten hours after the completion of this operation. On examination after death the ligatures were found to have been properly applied, but, contrary to what was supposed, the axillary artery was uninjured; the blood came from one of its branches, the inferior thoracic, which was completely cut across about a centimetre or thirty-nine hundredths of an inch, or *five* lines from its origin from the axillary artery.—*From the Archives Générales, p.* 101, 1842, *Annales de Chirurgie*, page 19.

The editor of the Lancet comments as follows on this case in the volume for 1841-42, page 230:—

"Our object in noticing the case is, not only to furnish our readers with one of the most striking instances of the folly of applying to wounded arteries the same operation as for aneurism, but also to make a few practical remarks, which we believe will be found in none of our surgical works. Where a large artery, whether it be the principal artery of a limb, or one of its branches, is wounded, it is an established rule to tie the artery above and below the wound; two ligatures are therefore required, but in some cases, the above for example, instead of two, three ligatures would be requisite. A butcher (says M. Laugier, in his *Bullétin Chirurgicale*) cut his wrist deeply; hemorrhage ensued; compression of the brachial artery arrested it; but circumscribed pressure on the radial above and below the wound had no effect. The wound was enlarged, and the blood was perceived escaping from an opening in the ulnar side of the radial. Two ligatures were applied, one above, the other below the opening; the hemorrhage however continued. It was thought for a moment that the interosseus might have been wounded, the knife having passed deeply from without inwards, but on examining carefully, the superficialis volæ was seen bleeding; it had been divided immediately at its origin, on a level with the radial. A ligature was passed around it, and the hemorrhage ceased. Let us now examine what would have occurred in case No. 118 if, as he should have done, the surgeon had enlarged the wound, and attempted to tie both ends of the bleeding artery. The inferior thoracic had been divided close to its origin from the axillary, leaving scarcely sufficient length for the ligature of its upper orifice; it would therefore have been requisite to have placed a ligature round the axillary, above and below the origin of the thoracic, and, in addition, a third ligature round the inferior orifice of the divided thoracic, from the numerous anastomoses between it, the internal mammary, and superior intercostal arteries. It may be objected that the third ligature could be advantageously replaced by compression. This might be true in M. Laugier's case, where pressure on the superficialis volæ, as it passes over the carpus, could be easily effected; but it would have been wholly inapplicable to case No. 118 from the depth of the axilla, and from the impossibility of applying compression methodically. We have thrown out these few remarks, as similar cases may occur, and prove extremely troublesome and puzzling."

I have placed these two cases in juxta-position, because no two can be found more exactly resembling each other, as far as regards the defective nature of the principles on which they were treated. Both were supposed to be cases in which the main trunk of a large artery was wounded. In both the main trunk was tied at a distance from the part wounded; and in both the patients died of evils foreign to the original injury. On examination after death it was found that a great mistake had been made in both—that in neither had the main trunk been injured. The criticism of the editor of the Lancet on the French case, No. 118, is honest, true, and just, although too severe. It is as applicable to 117 as to 118, to one operation as to the other, and must be applied to both, unless there is one manner of criticising French surgery, and another for English surgery. The French surgeons committed, in my opinion, an error in principle only. The impromptu manner in which they first tied the subclavian artery, and afterwards the arteria innominata, is above all praise. They showed an admirable knowledge of anatomy combined with great surgical dexterity. The English surgeons showed equal anatomical and surgical skill and ability, and are no less deserving of the highest commendation. They both, however, deviated from those principles which are so well laid down by the editor of the Lancet—principles which I have advocated for so many years, and which I am now endeavouring to enforce—they all failed in consequence, and lost their patients through errors in principle, but not in practical surgery.

This they deny, and on the contrary affirm, that the principles and the practice pursued in these cases are not only the correct principles and practice, but that they ought to be followed in similar instances. Some other surgeons of character and estimation have supported their views, and others, of even perhaps greater reputation in England, Ireland, France, and America, have lately concurred in the expression of the same sentiments. The gentlemen concerned in cases 117 and 118, are not only acquitted by them of any error, but they are authorised, as far as their approval goes, to do the same thing again; and there can be little doubt if other cases of the kind were to occur, that there are surgeons to be found who would adopt a similar practice, to be followed in all probability by the same fatal results. It is not, then, a persona question founded on envy, malice, and all uncharitableness, which is to be discussed, as it has been hastily said to be; but a great principle in surgery, implicating life to the utmost extent. It is a principle on which there cannot be a compromise—the Hunterian theorists are right or wrong. They must overcome the observations, the practice and the principles formed and established during the late war in Portugal, Spain, France, and the Netherlands; or they must yield even if they will not acknowledge

their errors. That they are discomfited is proved by almost every case I have adduced, and if anything were wanting to render their defeat more complete it is to be found in cases 117 and 118. They are like beacons on each side of the Channel, standing out in all the refulgence of their light, to warn future surgeons of their respective countries from the paths of error and of death.

The French surgeons were compelled to do something or let their patient bleed to death. They proceeded therefore to do the right operation of arresting the flow of blood through the artery, by placing a ligature upon it. They applied it however according to the Hunterian theory, on the wrong artery and in the wrong place, and lost their patient, which they would not have done in all probability if they had tied up the hole in the artery which really was wounded, instead of the trunk of one that was uninjured; but from which it sprung at the distance of five-twelfths of an inch, a distance sufficient to have enabled the surgeon to have applied a ligature with safety and success. The English surgeons tied the main trunk at a distance instead of the wounded branch, committing the additional error of disregarding that essential principle of surgery, which declares that an operation is not to be done on a wounded artery unless it bleeds. The examination after death proves that the small artery which had been injured had ceased to bleed, that it was not likely to bleed again, that the quantity of blood effused did not exeeed three ounces, and that even this was firmly coagulated. If the bleeding had been renewed, and the blood had escaped through the opening in the outer part of the thigh in such quantity as to render some operative assistance advisable, or if the blood could not find issue at the moment through the opening, in consequence of some part of the track of the injury having closed, and the tumor had increased, and *was manifestly increasing* to a size so considerable as to be capable of containing from eight to twelve or sixteen ounces of blood, an incision should in either case have been made through the wall of the tumor, and the wounded vessel exposed and secured, whatever it might have been; by which proceeding all possibility of mistaking the wounded artery must and would have been avoided.

According to the principles I maintain to be correct, no operation whatever should have been done in this case, and none would have been required; or if one should have become necessary from any accidental or incidental cause, it need have been nothing more than a simple incision for the evacuation of the contents of the swelling and for the ligature of the small vessel injured. According to the principles maintained by my opponents, they could do neither more nor less than they did: they lost their patient in consequence, and they will generally do so when they act on similar principles on similar occasions. It is for the profession to decide whether principles so deadly in their application shall be any longer permitted.

Three supporting and exculpatory hypotheses have been brought forward and for the first time in aid of the Hunterian theory, all of which I have shown and proved to be worthless:—1st. The supposed insecurity of a ligature placed on the upper part of the femoral artery when in a sound state, has no foundation, as several of the cases I have adduced distinctly show. 2nd. The fear of tying a branch of an artery an inch from its origin lest it should give way from this cause, is thoroughly disproved by the experience of every man who has amputated arms at or near the shoulder-joint. In my book on the Diseases and Injuries of Arteries I have said, page 376, "I have seen the epigastric artery divided in the operation of placing a ligature on the external iliac artery and two ligatures placed upon it without any inconvenience occurring; and I have reason to know that this artery is made a greater bugbear than there is any occasion for in all operations on these parts. If the surgeon has unluckily divided it, either in this or in any other operation, all that he has to do is to enlarge the incision, and tie both the divided ends; and I have no hesitation in saying it will not be of any consequence, either in this operation or in one for hernia." I was not aware when I wrote that passage, some sixteen years ago, that there would be a day when theory would attempt to refute what ample experience had fully established. As to the 3rd, or the fear that the loss of blood consequent upon the opening of an aneurismal swelling may destroy the patient, I can only say, that as far as my knowledge extends no such thing has ever occurred, and as it never could have occurred in the hands of any of the very able French or English surgeons who were concerned in the two cases alluded to, I shall not take the trouble to refute the possibility of an occurrence which I am satisfied never could have taken place.

The great principles of surgery to be observed in cases of wounded arteries, especially such as the axillary and the femoral, and which ought never to be absent from the mind of the surgeon, are two in number:—

1. That no operation ought to be performed on a wounded artery unless it bleeds.

2. That no operation is to be done for a wounded artery in the first instance but at the spot injured, unless such operation appears to be impracticable.

When Mr. Hunter impugned the principle on which his predecessors and his cotemporaries acted in cases of diseased arteries admitting of surgical operation, he neither doubted their skill, their ability, nor their anatomical knowledge; he merely said to them, the principle on which you proceed is bad; it causes you to do your operation in the wrong place. Change your principle, do your operations with the same knowledge and the same dexterity as at present, but do them in a different place. The difference which existed between Mr. Hunter and his cotemporaries is exactly the difference which exists at the present moment between me on one side, and my opposing cotemporaries

who think and act differently on the other. It has nothing to do whatever with the professional character, ability, or dexterity of any of them; it is simply a question of principle, and which party is right or which is wrong the profession must, I again repeat, decide. In the law, Chancellor No. 2 overturns the decisions of Chancellor No. 1; he in his turn is overruled by Chancellor No. 3, who, by another reverse of the wheel of fortune, finds himself in the condition of having his decrees overthrown in succession by perhaps both Nos. 1 and 2. These chancellors however always remain good friends, and the public have not a worse opinion of them than they had before they disagreed, not with each other, but with the law of the respective cases submitted for their decision. It ought not to be otherwise in surgery than in law. It is in man to err.

LECTURE VII.

Wounds and injuries of the throat and mouth implicating the carotid artery; Case of fatal ulceration of the carotids caused by a foreign body in the œsophagus; Staff-Surgeon Collier's case of wound at the angle of the jaw, penetrating into the mouth; Severe consecutive hemorrhage; Successful ligature of the common carotid; Mr. Mayo's case of hemorrhage from ulceration of the pharynx; Successful ligature of the right common carotid; Mr. Luke's case of hemorrhage from ulceration of the throat; Successful ligature of the left carotid; Case of cut throat; Wound of the internal jugular vein, and of the external and middle coats of the carotid; Consecutive hemorrhage; Ligature of the common and external carotids, followed by death from weakness; Staff-surgeon Maling's case of ligature of the common carotid for a wound of the throat; The external carotid should generally be tied in all cases of hemorrhage from the throat which cannot be otherwise arrested; The ligature of the common carotid should be a last resource; The consequences of ligature of the common carotid; Mr. Vincent's cases of paralysis following that operation; Sedillot's case of hemiplegia after ligature of the common carotid; Dr. Twitchell's case of sloughing of the internal carotid from a burn with gunpowder; Ligature of the injured vessel unsuccessful in arresting the hemorrhage; Success of compression; Dr. Warren's case of ligature of both carotids for erectile tumour of the lower lip and tongue; Treatment of wounds of the hand and foot, accompanied by hemorrhage; Wounds of the radial artery where it dips into the hand; Wounds of the ulnar artery; Case of wound of the ulnar artery near its origin; Ligature of the brachial; Failure of the operation in arresting the hemorrhage; Ligature of the ulnar artery; Remarks on the case; Wounds of arteries in bleeding; Case of wound of the brachial artery during venesection; Attempts to arrest the hemorrhage by compression; Ligature of the artery; Amputation and death; Circumscribed or diffused aneurism, aneurismal varix, or varicose aneurism, the result of wound of the artery in bleeding.

It is not possible in every instance to reach the wounded part of an artery without making greater sacrifices and without incurring greater dangers than are consistent with that prudence and discrimination which should distinguish an accomplished surgeon. Wounds and injuries of the throat and mouth, implicating the carotid artery, furnish the most prominent examples of difficulties of this nature, and the propriety of placing a ligature on the main trunk at a distance from the part wounded under these particular circumstances, must now be considered.

Case 119.—A soldier, in the year 1805, complained to me of sore throat, difficulty of breathing, and uneasiness in his chest, which he said arose from certain blows received from the drill serjeant in consequence of his awkwardness. No proof could however be brought of the blows or of any ill-treatment, further than that he had been drilled for several hours daily to make him keep his shoulders back, but in vain. The fauces were slightly reddened. After a few days the throat became more inflamed, although not to any great extent, and he was utterly incapable of swallowing anything but liquids. This was followed by a ptyalism, as if under the influence of mercury, which induced me to tax the man with having made himself ill, but he would not acknowledge it, although I promised him a pardon on telling the truth. He soon began to spit blood, of a light scarlet colour, but without any cough; and this increased in quantity daily, until at last the orderly informed me there was a coagulum in the bottom of his spitting pot every morning, equal to six or eight ounces of blood. A day or two afterwards the blood began to pour out of his mouth so rapidly, that he sent for me. I arrived however only in time to see the blood fill the chamber-pot, when he fell back dead. On opening the body, I found an instrument lying across the commencement of the œsophagus, composed of two half phial corks, fastened together by strong thread, having previously had three pins thrust through each of them, so that the heads of the pins were applied to each other, back to back, the points sticking out beyond the cork, forming a sort of chevaux-de-frise: this, it is presumed, he covered with fat, and attempted to swallow; but the point of a pin catching, the efforts to swallow turned the machine across. In this situation the points of the pins were close to the carotid arteries, and having by degrees given rise to ulceration of the œsophagus, wounded them on both sides; every elongation or pulsation of the arteries having brought them against the point of one or more of the pins, the marks of which were observable in several small holes of different sizes on the sides of the vessels. As one or two of these became larger, from the constant attrition,

blood came through into the œsophagus; and as they again increased by ulceration, larger holes were formed, from which the sudden and fatal hemorrhage took place. The instrument and the arteries I sent from North America to the late Dr. Hooper, and they ought to be in the museum of King's College.

Case 120, by Staff-surgeon Collier.—William Ball, 44th regiment, aged twenty, was wounded by a spear or sword, on the 17th of June, which passed in at the angle of the left jaw, and penetrated the mouth, lacerating the tongue severely in three or four places. He was brought into hospital in Brussels on the 19th, and had, by his account, lost a considerable quantity of blood on the way. On the evening of the 22nd I found arterial blood jetting up with considerable force from the bottom of a narrow deep wound, and flowing in different directions as if from several branches of the external carotid. I attempted dilatation; but as all efforts to trace the sources of bleeding were fruitless, I applied steadily and forcibly graduated compresses, moderating the flow of blood by pressure on the carotid. Although the hemorrhage yielded for three or four minutes, it was soon evident it had only changed its channel, for it began to flow as furiously through the mouth as it had before done through the wound, and the coagula required to be constantly removed to prevent suffocation. My opinion being, that the patient's preservation depended on securing the common carotid artery, I performed the operation at eight o'clock that evening; the hemorrhage ceased the instant the ligature was applied. In two hours after the operation, the patient was quite tranquil and sensible; the pulse feeble; countenance very pale. On the following morning (23rd) I found him perfectly sensible and easy, with the exception of some sense of heat in the throat, rather increased since the operation; the pulse was 96, with slight sharpness; no appearance of hemorrhage. On the 5th of July the ligature came away, and on the 12th of August he was discharged cured, having suffered only from two slight attacks of erysipelas of the face, which gave no uneasiness.

Case 121, by Mr. Mayo.—John Webb, aged twenty-three, was admitted into the Middlesex Hospital on the evening of the 18th of October, in consequence of a great loss of blood from an ulcer in the right side of the throat, which returned with such violence the next morning, the 19th, as to cause Mr. Mayo to place a ligature on the right common carotid, which arrested the bleeding. On the 3rd of November, the fifteenth day after the operation, the ligature came away from the artery. The ulcer of the pharynx had begun to cicatrize, and the patient shortly afterwards recovered.

Case 122, by Mr. Luke.—T. B., aged forty-five, a tall muscular man, was affected by sore throat for three weeks, and was awakened in the morning by something flowing from his throat, which proved to be blood, of which he lost four pints before it stopped. On the 3rd of October, three days afterwards, the bleeding returned, but soon ceased. In about a quarter of an hour he had lost between three and four pints of blood. October the 4th.—At 4, a. m., bleeding again returned. The patient was sensible, but apparently indifferent to surrounding objects. He had lost at this bleeding more than three pints of blood, and it seemed almost certain that he must die if another bleeding should take place. Mr. Luke therefore tied the carotid artery on the left side, that being the trunk which the circumstances of the case indicated to be the source of the bleeding vessel. The operation succeeded in stopping the bleeding, which recurred once, seven days after the operation, to the amount of two ounces. The two ligatures, which had been applied about half an inch apart without dividing the artery between them, came away on the twenty-second day after their application, and the patient perfectly recovered.

Case 123.—I was sent for into Jermyn-street to see a gentleman, who in a moment of great anxiety of mind had cut his throat with a razor, and fell bathed in blood. The bleeding was arrested by thrusting sponges into the wound. The cut had been made with great violence across the throat, but was deepest on the left side, having laid bare the left carotid, and wounded the internal jugular vein, from which the principal bleeding came. The opening in the vein being distinct, I passed the point of a tenaculum through the edges made by the cut into it, and drawing them together in this manner, passed a single silk thread around so as to close the opening, without destroying the continuity of the vessel. The ends of the ligature were cut off close to the knot. The carotid was then clearly seen by the side of the vein, having a transverse mark or cut upon it, which did not appear to penetrate beyond the middle coat; and after due consideration, it was presumed that this wound might heal, without requiring a ligature to be placed upon the artery. On the eighth day arterial hemorrhage took place, and on opening the wound it came evidently from that part of the carotid which had been cut. I placed a ligature upon the common carotid immediately below this opening, but the flow of blood was scarcely diminished in quantity by it, in consequence of the reflux from the head. On attempting to apply another ligature above the opening, I found, as I had before suspected from the situation of the wound, that it was immediately below the division of the common carotid into the external and internal carotid arteries. The hemorrhage ceased on placing a ligature on the external carotid, above the wound in the artery, and as the patient was greatly exhausted, I refrained from tying the other. The bleeding did not return, but he died the next morning from weakness.

On examination after death, the internal jugular vein was found pervious, and without a mark indicating where the ligature had been applied. The origin of the internal carotid was filled for about a quarter of an inch with a soft coagulum of blood; the remaining part up to its entrance into the skull

was empty. The wound was exactly below the bifurcation of the artery, and the ligature on the external carotid might have been sufficient if the patient had lived.

This case will serve as a guide under similar circumstances. It shows that where an opening is made into a vein of the size of the internal jugular (its division not having been accomplished), a ligature may be made to include the cut portion without interfering with the canal of the vessel; and that where the two outer coats of a large artery are divided, it will be better to place a ligature above and another below the injured part at once, rather than leave it to the efforts of nature alone. A direct wound of the common carotid is usually fatal from loss of blood.

Case 124.—A soldier of the rifle brigade at Ypres, was wounded by a penknife in the throat, and bled profusely. Staff-surgeon Maling tied the common carotid above and below the wound, and succeeded in arresting the hemorrhage, although the patient did not eventually recover. The practice in such cases is clear, and ought to be decided.

In all cases of hemorrhage from the throat, which cannot be suppressed without tying the carotid artery, it is generally the external carotid which ought to be tied, and not the trunk of the common carotid. There is not sufficient reason for cutting off the supply of blood to the head by the internal carotid, unless the operation on the external should fail, when the common carotid may be tied as a last resource.

The common carotid artery has been tied several times for wounds inflicted on it, or on one of its two divisions, by foreign substances forced through the mouth into the tongue and throat. These persons have generally died from repeated bleedings, although some have recovered altogether, and others have failed and died ultimately from abscess in the brain, or after attacks of paralysis, caused by disease in that organ—the result probably of a defective supply of blood, of which Mr. Vincent has given the particulars of two cases in the *Medico-Chirurgical Transactions* for the present year.

Case 125.—Mr. Vincent tied the right common carotid of John Mason on the 18th July, 1828, for an aneurism. In the evening the patient suffered from convulsions on the same side, which continued, and were followed by paralysis of the left side. The man died on the 24th. The brain on the right side was found soft and disorganised.

Case 126.—Wm. Brown, aged twenty-eight, was wounded on the 9th April, 1845, by a tobacco-pipe, which, forced into the mouth, penetrated the root of the tongue on the right side. On the 16th great hemorrhage took place, which induced Mr. Vincent to place a ligature on the common carotid artery. Paralysis of the left side immediately followed, with twitchings on the right. On the 21st he died, and the brain was found softened and disorganised on the right, or the side on which the artery had been tied.

Case 127.—M. Sedillot, *Gazette Medicale*, September 3rd, 1842. Charles Muller, ten years old, was wounded by a very sharp knife below the right side of the jaw, near the ear; which bled very freely at times, until the 5th day, when Dr. Francois attempted alone to tie the carotid; bleeding ceased for three days, when it returned, and Professor Sedillot was called in consultation. The professor says, "I insist on every occasion on the importance of the precept, to tie wounded arteries above and below the part injured. One avoids by this a thousand accidents, and the greatest dangers. This time, in the midst of mortified and diseased parts, I thought it better to tie the primitive trunk, surrounded even as it was by parts altered by the indurative and suppurative process." Three hours afterwards, complete hemiplegia of the left side of the body and of the right side of the face appeared, and the patient died ten days afterwards. Dissection showed the external carotid open, with a wound in it, but not divided. Both ends had bled. The head having been injected from the left or opposite carotid, it was found that the portion of the right common carotid above the ligature contained injection, brought into it by the internal carotid, by the facial, and particularly by the superior thyroid, and some large branches anastomosing with the internal carotid of the opposite side.

Remarks.—With respect to derangement of the brain, Le Noir reports in the *Dictionnaire des Etudes Medicales* that out of sixty-five cases he had collected, three died of delirium and convulsions, one of adynamia, four from hemiplegia. In two others the intellect was weakened, in three vision was rendered defective on the opposite side, the brain showed a want of blood, and a softening of the right anterior lobe.

Case 128, by Dr. Twitchell, of Keene, N. H., United States.—A soldier in a sham fight, in 1807, received a wound from the wadding of a pistol on the right side of the head, face, and neck, which were much burned. A large wound was made in the mouth and pharynx; nearly the whole of the parotid gland, with the temporal, masseter, and pharyngeal muscles were destroyed. The neighbouring bones were shattered, and the tongue injured. The hemorrhage was not copious, although the external carotid and its branches were divided. Ten days after the accident the sloughs had all separated, and left a large circular aperture of from two to three inches in diameter, at the bottom of which might be distinctly seen the internal carotid artery denuded from near the bifurcation of the common trunk to where it forms a turn to enter the canal in the temporal bone. Directly on this part there was a dark speck of a line or two in diameter, which suddenly gave way whilst Dr. Twitchell was in the house. With the thumb of his left hand, he compressed the artery against the base of the skull, and effectually controlled the hemorrhage. The patient fainted. As soon as he was recovered, the doctor says, "I proceeded to clear the wound from blood, and having done this I made an incision with a scalpel downwards, along the course

of the artery, to more than an inch below the point where the external branch was given off, which, as stated above, had been destroyed at the time of the injury. Having but one hand at liberty, I depended upon the mother of the patient to separate the sides of the wound, which she did, partly with a hook, and occasionally with her fingers. At length, partly by careful dissection, and partly by using my fingers, and the handle of the scalpel, I succeeded in separating the artery from its attachments, and passing my finger under it, I raised it up sufficiently for my assistant to pass a ligature round it. She tied it with a surgeon's knot, as I directed, at about half an inch below the bifurcation." Dr. Twitchell removed his thumb, and sponged away the blood, not doubting that the hemorrhage was effectually controlled; but, to his surprise and disappointment, the blood immediately began to ooze from the rupture in the artery, and in less than ten minutes it flowed with a pulsating jet. He compressed it again with his thumb, and began to despair of saving his patient, but resolved to make another attempt. Raising his thumb, he placed a small piece of dry sponge directly over the orifice in the artery, and renewed the compression till a rather larger piece of sponge could be prepared. He placed that upon the first, and so went on pressing the gradually enlarged pieces obliquely upwards and backwards against the base of the skull, till he had filled the wound with a firm cone of sponge, the base of which projected two or three inches externally. He then applied a linen roller in such a manner as to press firmly upon the sponge, passing it in repeated turns over the head, face, and neck. On the 30th of December he was discharged cured, several fragments of bone and two teeth from the upper jaw having been cast off. Some deformity remained, in consequence of the depression on the side of the face.

Remarks.—This case shows very distinctly how readily the internal carotid can bring its reflux blood into the common trunk, whence it may ascend against gravity in the external carotid, and renew the bleeding, even if it should not be done by other anastomosing branches, as in Case 128.

Case 129.—Dr. J. M. Warren, of the Massachussetts General Hospital, tied the left carotid, on the 5th of October, 1845, for a case of erectile tumor of the lower lip and tongue, which had supervened on a mark occupying nearly the whole of the left side of the face and head. The patient recovered, and considerable diminution of the swelling followed. On the 7th of November, the right carotid was tied, the vessel being dilated to one-third more than its natural size; slight faintness and drowsiness followed the operation, and the patient recovered without further inconvenience. After some other operations about the part affected, the patient returned home cured. No pulsation could be discovered in the temporal, nor in any arteries of the head. In the neck, just above the clavicle, two large arteries were seen pulsating under the skin, being in all probability the suprascapulares greatly enlarged. No affection of the brain followed the double operation.

Wounds of the hand and foot, accompanied by hemorrhage, and which may be considered to be deep-seated wounds, are often exceedingly troublesome. The same rules are however applicable to them—dilatation of the wound, and ligature of the vessel; or if this be not practicable, or be unsuccessful, compression on the principal trunk, and a graduated compress and bandage on the wound. The ulnar artery when wounded in the palm of the hand ought always to be secured by ligature. The radial being more deeply seated requires more precaution; and when an incision cannot be made of the necessary extent without injuring the median nerve or its branches, so as to paralyse the fingers, compression of both kinds should be tried. If the swelling of the hand will not admit of it, the radial artery should be first tied, and compression made on the ulnar, or a tourniquet may be applied on the brachial from time to time, and as a last resource, the ulnar artery must be tied also, but no one should rely on tying the brachial in the first instance; for, although such operation has succeeded, and may again succeed, it does so only by chance, and not by principle; inasmuch as the principle is that the collateral circulation should restore the bleeding. If the bleeding recur in spite of this and of the graduated compress, so applied as not to compress the whole hand, but only the bleeding part, and the swelling of the hand will not admit of its reapplication, the hand is still not to be amputated, but a clean and decided incision is to be made in the line of the wound, from the annular ligament to the finger (avoiding the flexor tendons), and down to the metacarpal bone, which bone and finger is *if necessary* to be removed; by which space will be obtained to see the bleeding vessels. The hand is only to be amputated as a last resource. The foot is to be treated in a similar manner. I have seen many cases of hemorrhage from both; but I never saw either removed in consequence of it.

It is in wounds of that part of the radial artery where it dips into the hand that surgeons have had most inclination to place a ligature on the brachial artery. My excellent friend, Sir G. Ballingall, says on this point:—"In two such cases I have successfully had recourse to the ligature of the humeral artery; and I have known the same operation twice executed with success by others. This is a practice which some will think more honoured in the breach than the observance; and it has I know been said, that there is no hemorrhage from vessels in the hand or foot which may not be restrained by pressure. This I believe may be true; but, on the other hand, I believe it to be equally true, that in certain states of a wound or ulcer the healing process will not go on nor the closure of the vessel take place under that degree of pressure which is necessary to suppress the bleeding; and it is by checking the flux of blood to the part, without irritating or inflaming the wound

itself, that I believe the ligature of the artery above to operate favourably in such cases."

When the ulnar artery is wounded a little below its origin, and whilst covered by the pronator teres, and the superficial flexors of the forearm, viz., the flexor carpi radialis, palmaris longus, and flexor digitorum sublimis, the artery is to be secured at the part injured by two ligatures. A most excellent writer on the arteries, and whose book as an anatomical work is invaluable, says, page 215, "In the superior third of the forearm, the great depth at which this artery lies from the surface, and the number of muscles which cover it, render it impracticable to pass a ligature around it." A very simple question naturally presents itself—why is it impracticable? The answer is, it cannot be laid bare unless the muscles named above be divided; but to the question why this should not be done, it would be difficult to reply, unless it be honestly answered, there is no reason why it should not be done, other than that it has not been usual to do so.

I shall refer to a case in point.

Case 130.—The surgeon says, "I was consulted in the following circumstances: — A child having a sharp pointed knife in its hand, had wounded the nursery maid below the elbow, and close to the ulna. The ulnar artery was wounded near its origin from the brachial artery. It bled profusely, and the surgeon tied the main artery by the side of the tendon of the biceps muscle. This stopped the hemorrhage for a time, but afterwards it returned from the wound. The ulnar artery was then tied below the wound, for it was apparent that the blood returned from below. What was next to be done if it should again bleed? Tie the radial artery. But it did not return. We see however the difficulties which overtake us when the primary branches are wounded near their trunks, and the surgeon will have to determine the propriety of tying the trunk, or of enlarging the wound, and tying the bleeding orifices. In this case there might have arisen a necessity for three operations instead of one. As it happened, it was dexterously done, and happily."

Remarks.—As there is no name given with this case, and I cannot hurt the feelings of any one by my remarks, I shall take the liberty of saying there never was anything done so directly contrary to the principles of surgery, in regard to wounded arteries. In the first place, for a wound of the ulnar artery, the brachial was tied, thus applying the Hunterian theory of aneurism to a wounded artery. In the second place, the ulnar artery was tied in a similar manner, some two or more inches below the wound, being a more pardonable error of the same kind. This operation succeeded, because the collateral branches had not time to bring the blood into the arteries below the ligature on the brachial, and above that on the ulnar artery, before they were closed by the inflammatory and natural processes. This case therefore furnishes another proof of the fallacy of the opinions on the collateral circulation which I have just exposed. The reporter does not however stop here; he comments upon it, by inquiring what was next to be done, if it had bled again?—and replies himself to the question—Tie the radial artery. Now it would be difficult to conceive why the radial artery should be tied for a wound of the ulnar, if the surgeon were not alarmed at the thought of dividing muscular fibres, in which the only difficulty lies. In order to avoid dividing muscular fibres, a separate and distinct artery is to be tied; and what could that operation have done? on what principle could it be useful? By tying the radial artery, the return of blood through it into the humeral end of the ulnar might have been prevented. But it would not *certainly* have been prevented, because there are radial, and ulnar, and interrosseal recurrents, all returning blood, or capable of doing it, after the lapse of a few days, into the cut and open extremities of the artery, and they might all require to be tied in succession. If the opinions entertained on the subject of the collateral circulation by its strongest advocates be correct, they must and would all have required it.

The error in this case was original. The surgeon should have made a clean incision down to the artery, through all the muscular fibres interposed between it and the surface, avoiding the median nerve, which runs between the two origins of the pronator teres muscle, and then he should have placed a ligature above, and another below the wound in the artery, and there would have been nothing more to do.

The person's life was endangered, two operations were done, and a third, and probably amputation as a last resource, were only avoided by an accidental circumstance, viz., that the cut end of the artery became impervious before the recurrent and collateral branches brought their blood round into it; and all this was incurred merely that a few muscular fibres might not be divided. It is necessary now to ask, what would be the consequence of this division? The utmost consequence which could ensue would be weakness of the arm in the performance of certain motions; but I have no hesitation in affirming that no such consequence would ensue. I have seen the parts divided—nay, I have divided them myself—and the patient has recovered without any sensible defect.

These remarks are taken altogether from my work published in 1830. I could not make them stronger or more effectively convincing to those who will allow themselves to be convinced.

Wounds inflicted on arteries in bleeding ought to be treated on the principles laid down for the management of wounded arteries generally. Whenever an accident of this kind occurs at the bend of the arm, and the bleeding cannot be effectually restrained by compress and bandage as in cases 1, 2, &c, an incision should be made down to the artery, and one ligature applied above and another below the wounded part. It is almost always the brachial artery that is wounded, and not the ulnar or radial, unless the latter is given off high in the arm. This practice would be seldom followed by

any bad or unfavourable result, if it were immediately adopted; but as the error is usually made by persons incompetent to the performance of the operation, the bleeding is in the first instance restrained by pressure, until its repeated recurrence renders other assistance necessary. The arm is then, in all probability, more or less injected with blood, inflammation has taken place, the constitution can scarcely have failed to sympathise, and the operation under these circumstances is frequently ineffectual; amputation follows, and death. The following case may serve as an example:—

Case 131.—A poor man had the artery opened at the bend of the arm in bleeding, and the operator, suspecting the accident he had committed, applied a compress and bandage to restrain the hemorrhage, which nevertheless recurred several times; on which he was sent to the hospital, with the arm inflamed, swelled, and injected with blood. The brachial artery was tied close to the wounded part, but as the bleeding returned, it was again secured a little higher up; but, as hemorrhage again took place, amputation was had recourse to, and the patient died exhausted.

Remarks.—On dissection, the brachial artery was found to be the vessel injured, immediately at its bifurcation, so as scarcely to allow of a ligature being applied to the trunk below. In this case, three ligatures would perhaps have been required in the first instance, one on each artery, viz., the trunk of the brachial, and the commencement of the radial and the ulnar arteries. I have preserved the parts. When the wound in the artery is of a small size, an operation is not always required, but that can be rarely ascertained until it is found that the injury is not followed by bad symptoms. When an operation is not performed, and pressure is applied, it is possible that the wound in the artery may heal, but this does not usually take place, and an aneurism is the consequence. This may be of two kinds—circumscribed or diffused. If the artery has been punctured below the bend of the elbow by an operation on the median basilic vein, the aponeurosis of the biceps muscle is interposed between the vein and the artery, and will tend under pressure to confine the effused blood, so that at last the inflammatory process will consolidate the surrounding parts, and, if the external wound close, give rise to a circumscribed aneurism. For this, if some weeks have elapsed, the operation of placing a ligature on the trunk of the artery may be had recourse to as near the aneurism as possible, the principal reason for doing it at a distance, viz., the diseased state of the artery, being wanting; and one ligature will be sufficient.

When the artery is wounded above the edge of the aponeurosis of the biceps, and the external wound closes, the effused blood may extend upwards in the course of the vessel, so as to form a diffused aneurism. These injuries are now of rare occurrence in England, and my opportunities of seeing them have not been so frequent as to enable me to lay down rules for their treatment with that confidence with which I write on all other points. I shall therefore refer to the best authority I know—to the recorded opinion of the late Dr. Colles, of Dublin, as stated by Mr. Harrison,—accidents of this kind being apparently more common in that city and in its vicinity than in London and its neighbourhood. He says, "I have operated repeatedly, and with success, for the cure of brachial aneurism, in consequence of injury to the artery in performing venesection. I have also frequently assisted others in operating for the same cause, and with the same result; and I never yet found it necessary to open the aneurismal sac, or to look for the vessel below the tumour, or to apply more than one ligature around the artery, and which I think ought always to be tied as near as possible to the seat of the disease." This method of treatment, combined with moderate pressure along the aneurismal sac, the horizontal position, and if necessary active depletion, will rarely fail of success. It should, however, be borne in mind that if the surgeon on committing the error applies his compression on the artery in a methodical manner, and before any extravasation takes place into the surrounding parts, he will rarely fail of success, as in case No. 1.

If the wounded vein should adhere to the cut edges of the wounded artery—leaving a direct communication between the one and the other—the blood is propelled into the vein, enlarges it, and constitutes what is called an *aneurismal varix*. But if there be any cellular texture interposed between the opening in the artery and vein, yet communicating with both, it gives rise to the change of denomination to *varicose aneurism*. Neither of these complaints, which are essentially the same, requires an operation in the generality of instances; after attaining a certain size and appearance, they often remain stationary through life. When either from the increase of size of the swelling, or the anxiety of the patient, an operation is considered necessary, it should be done by incision at the part, and the application of two ligatures to the artery; for although in some cases one has been found sufficient, the records of surgery furnish abundant proof that blood has been returned to the sac by the anastomosing branches, and a second operation has been required to effect a cure, the conclusion to which M. Amussat has arrived and declared in his memoir, inserted in the *Journal de Chirurgie* of M. Malgaigne, for 1843.

LECTURE VIII.

General Conclusions; The operations for placing a ligature on the aorta, the common trunk of the iliac, and on the internal and external iliac arteries; The operations for placing a ligature on the gluteal and sciatic arteries; The operations on the femoral artery.

The very great inconvenience these lectures have given me at this season of the year, causes me to defer the remaining four until the autumn, when I will make the four, eight, with the hope you may reap some advantage from the additional number. By the rules of this hospital the surgeons must all be, or have been, teachers or demonstrators of anatomy, or surgeons or assistant-surgeons of hospitals devoted to cases of general surgery. The ground on which it is built, is held on the condition that lectures on general as well as on ophthalmic surgery, shall be given to the medical officers of the public service from time to time, and that the hospital shall always be open to their attendance on the recommendation of the heads of their respective departments. It is the duty of the surgeon to give notice when he intends to begin these lectures, and you may rely upon its being given as a part of that duty. I am obliged by the attention you have paid, and shall be glad hereafter to see as many as may please to attend. You are all aware, however, that it is indifferent to me whether there are three, thirty, or 300, as I am not lecturing for money, and I never disallowed the attendance of any one, when I did do so.

I have brought together certain precepts, with which I shall conclude these lectures; I had intended to have gone through the principal operations with you, but there is not sufficient convenience here at this hot season, and I really have not time to spare. I shall give the description of them to the reporter, who will publish them if he sees fit.

GENERAL CONCLUSIONS.

1. The Hunterian operation for the cure of an aneurism is not applicable to the treatment of a wounded artery, inasmuch as the wound of the artery communicates with the external parts, and nothing intervenes to prevent blood flowing from the wound in its side, or from its cut extremities.

2. When a large artery is divided and bleeds, the wound should be enlarged if necessary, and a ligature placed on both the divided ends; but if the artery be only injured and not quite divided, the ligatures should be applied one immediately above, the other below the injured part. The artery may or may not be then cut across, at the pleasure of the operator, but the limb or part should be placed in a relaxed position. A bandage should not be applied, and the edges of the wound should be simply brought together by adhesive plasters, which do not extend completely round the limb.

3. No operation is to be performed on any artery unless it bleeds at the moment of its performance, inasmuch as hemorrhage once suppressed may never return.

4. The intervention of muscular fibres, or of whole muscles, is not a sufficient reason for tying the artery at a distant part. They must be divided, if it be possible, to the extent required for a due exposure of the injured artery and its accompanying veins and nerves.

5. If the wound pass indirectly to the principal artery, from the back of the thigh for instance to the femoral artery in front, or from the outside of the arm to the humeral artery on the inside, the surgeon may (on satisfying himself of the part likely to be injured, by the introduction of a probe) cut down on the vessel opposite the part supposed to be wounded, by the most simple and approved method. When the artery is exposed, the probe will point out the spot at which the vessel has in all probability been wounded. Pressure made below this spot on the artery, will cause it to be distended and to bleed, if the flow of blood be not prevented from above; the artery is then to be secured by two ligatures, and the lower one should if possible be applied first.

6. The tourniquet should never be used in an operation for aneurism or for a wounded artery. Compression by the hand in the course of the wounded vessel is allowable.

7. The blood from the upper end of a divided artery, or that nearest the heart, is of a scarlet arterial colour.

10. The blood from the lower end of a divided artery, or that which is furthest from the heart, is of a dark or venous colour, when it happens to flow immediately after the division of the vessel. At a subsequent period it may assume more of the colour of arterial blood, but it rarely does so for several days after the receipt of the injury, and always flows, or at least until a very late period, in a continued stream.

11. This regurgitation or flow of blood from the lower end of a divided artery is a favourable sign, inasmuch as it shows that the collateral circulation will probably be sufficient to maintain the life of the extremity.

12. The collateral circulation is in almost every instance capable of maintaining the life of the upper extremity when the axillary artery is divided, and the colour of the blood which flows from the end of the artery, on its being divided, is not always as dark as in the lower extremity, and it sooner resumes its arterial colour.

13. The collateral circulation is not always capable of maintaining the life of the limb when the femoral artery is injured. The best assistance which art can give is to rub the foot and leg in the gentlest manner, between the hands of one or two strong young women, for several hours, or even for the first three or four days; relaxing this process very little, even during sleep. When the vein is divided at the same time, or rendered impervious, the limb usually mortifies.

14. The collateral circulation is sufficient to maintain the life of an extremity in almost every case in which an aneurism has existed for eight or ten weeks, although it may be incapable of doing this if the principal artery have been suddenly divided, without any previous disease having existed in the part.

15. The theory and the operation for aneurism are never to be applied to the treatment of a wounded artery, which has caused a diffused or circumscribed aneurism, *whilst the external wound communicates with the artery*, unless it be impossible or impracticable to tie the bleeding vessel.

16. When an artery has been wounded, and the external opening has healed for weeks or months, so as to give rise to a diffused or circumscribed aneurism, it may be treated according to the theory of aneurism occurring from an internal cause, if the case will permit it without danger; although with this difference, that as the artery is sound the operation may be performed close to the tumor. If any doubt exist as to the capability of the collateral circulation to support the life of the lower extremity, after the external iliac has been secured by ligature, the operation should be performed at the injured part by opening the swelling and enlarging the wound, as in the case of a wounded artery.

17. When a circumscribed or diffused aneurism which has formed after a wound has been opened, whether by accident or design, it is placed in the situation of a wounded artery, and should be treated as such. If the aneurism has arisen from disease of the vessel, and the wound or opening into it cannot be permanently closed, the limb is in a worse state than if the artery had been wounded by accident; because a ligature or ligatures placed on a diseased artery are little likely to be successful. They are liable to all the difficulties and inconveniences attendant on the old operation for aneurism. If a case of the kind should occur in a popliteal or femoral aneurism, situated at or below where the artery passes between the triceps and the bone, amputation, if it can be done low down, will be the best remedy. If the aneurism should have formed higher up, and the opening can be closed with any prospect of its healing, a ligature may be placed upon the artery above it; but on the recurrence of hemorrhage which cannot be restrained by moderate pressure, the artery must be tied below, or recourse had to amputation. It is, however, to be observed, that amputation under these circumstances, when resorted to as a third operation, rarely succeeds.

18. When an artery is wounded with a simple fracture of a bone, or with a comminuted fracture of smaller bones, with an external communicating opening, both ends of the artery should be secured, and the limb treated in the usual manner.

19. When the bone broken is the femur, and the artery divided is the femoral artery, the operation of amputation will generally be advisable. It will always be so if the fracture is a comminuted one, or the shaft of the bone is extensively splintered.

20. When the broken bone injures the artery and gives rise to an aneurism, the treatment is to be first of the fracture and then of the aneurism, as soon as circumstances render it advisable or necessary to have recourse to the operation for aneurism; which can only be after time has been given for the collateral branches to enlarge, so as to maintain the life of the limb.

19. When mortification takes place in addition to, or as a consequence of a wounded artery, amputation should be had recourse to forthwith.

20. The place of operation should be in almost all cases at the seat of the original wound; but there may be an exception, viz.,

21. When, for instance, the injury has been a mere cut, just sufficient to divide the artery and vein immediately below Poupart's ligament, and mortification of the foot supervenes, amputation should then be performed below the knee, or at the part where the mortification more usually stops for a time, as in Case 96.

This rule is founded on the observation, that great efforts are made by nature to arrest mortification a little below the knee. Sometimes they succeed; when they fail, death is almost inevitable. The advice to amputate at this part is founded on the fact of its being infinitely less dangerous, when done there, than on the thigh, independently of saving a joint.

22. When mortification has *continued for several days*, and is spreading without having once stopped, the constitution of the patient being implicated as marked by fever, amputation should not be performed until the mortification has been arrested and the line of separation has been well formed. In many cases, where there is great weakness or of irritability of constitution, it will be advisable to defer the operation to a later period, particularly if there be hope of the patient's becoming stronger and more tranquil.

23. If the mortification has once stopped and

then begins again to spread, it will never again cease to extend, and amputation may give some chance of life.

24. Amputation of the arm should never be had recourse to, in consequence of a wound of the axillary artery, unless mortification takes place.

25. When mortification takes place after the operation for aneurism, the surgeon must be guided by the state of the patient's constitution, in resorting to or refraining from amputation.

26. When hemorrhage occurs from the surface of a stump, the artery should be tied at the part from which the blood comes in the first instance, if it can be easily done. If this should not suffice, the artery must be tied higher up, just at such distance as will afford a fair hope of its not having been affected by the derangement of the stump, which has led to the failure of consolidation in the extremity of the artery; yet not too high to admit of the junction of any large collateral branches. If the bleeding proceeds from several small vessels, and cannot be arrested, the principal trunk should be tied immediately above the diseased part, and the patient removed to a purer atmosphere, without which an operation rarely succeeds in any case.

27. When an aneurismal tumor mortifies, it is unnecessary and improper to tie the artery above the tumor, because it will be obliterated if the mortification be arrested by the efforts of nature, which the operation may interfere with, and even prevent, whilst, if the mortification spreads, it will be a matter of supererogation, and only hasten the patient's dissolution. When an aneurism inflames, is opened by ulceration, and bleeds profusely, so as not to be arrested, it is a proper case for amputation, if such an operation can be performed.

On the Operations of placing a Ligature on the Aorta, on the Common Trunk of the Iliac, and on the Internal and External Iliac Arteries.

In performing either of the three operations, it is advisable to compute the point at which the artery is to be tied, with relation to the umbilicus and the anterior superior spinous process and the crest of the ilium. The aorta bifurcates usually on the body of the fourth, or on the intervertebral substance between it and the fifth vertebra, although it may be higher or lower, which cannot be ascertained previously to the operation; the most usual place being nearly opposite to the margin of the umbilicus on the left side. It is about half an inch above this that the ligature should be placed on the aorta, if this operation is ever done again, rather lower than higher, on account of the origin of the inferior mesenteric artery. As the aorta is to be reached by carrying the finger along the common iliac, the comparative situation of that vessel is next to be estimated.

The aorta divides into the two common iliac arteries, the length of which varies according to the stature of the patient, and the place at which the aorta bifurcates. The common iliacs again divide into the external and internal iliacs, which division is usually opposite to the sacro-iliac symphysis. The length of the common iliac artery is therefore tolerably well defined, as scarcely ever exceeding two inches and three quarters, and seldom being shorter than two inches. The external iliac is a little longer than the common iliac, and the place of subdivision of the common iliac into external and internal can always be ascertained during an operation, by tracing the external iliac upwards to its junction with the internal iliac to form the common trunk, which proceeds upwards and inwards to the aorta. The left margin of the umbilicus being taken as a point opposite to that which may be presumed to be the part at which the aorta divides, and the situation of the external iliac becoming femoral being clearly ascertained, a line drawn between the two will nearly indicate the course of these vessels; sufficiently so at all events to enable the operator to mark with his eye the place where he expects to tie the artery, and to regulate the length of the incision, so that this ideal spot may correspond to its centre. It is necessary to recollect also, that the whole of one hand and part of the other must be introduced into the wound, to enable the operator to pass the ligature round the artery, and to tie the knots; so that an external incision of less extent than five inches will not suffice, and six will afford a facility in operating, which will save pain to the patient, and inconvenience to the operator. In calculating the length of the incision, allowance must be made for the size, obesity, and muscularity of the patient. If a rule be placed on the crest of each ilium, about one inch and a half behind the anterior superior spinous process, it will pass in a well-formed man across the junction of the fifth lumbar vertebra with the upper part of the sacrum, and a little way behind where the common iliac divides into external and internal. The centre of an incision, six inches in length, beginning about half an inch above Poupart's ligament, and about the same distance to the outside of the inner ring, and carried upwards, will fall nearly on a line with this point. The incision should be nearly parallel to the course of the epigastric artery, but a little more to the outside, in order to avoid it and the spermatic chord, and having a gradual inclination inwards towards the external edge of the rectus muscle, the patient being on his back, with the head and shoulders raised, and the legs bent on the trunk. The aponeurosis of the external oblique muscle having been opened inferiorly, is to be slit up for the whole length of the external incision; and the director having been first passed under the internal oblique muscle, through a small opening carefully made into it, it is to be divided in a similar manner. The transversalis is then to be cut through at the under part, and its tendinous expansion divided at the upper part, the greatest precaution being taken by the finger to prevent the peritoneum from being injured. The fascia transversalis is then to be torn through at the lower and outer part, so that the fingers may

be passed inwards from the ilium, and the peritoneum detached from the iliac fossa, and turned with its contents inwards, by a gradual and sidelong movement of the fore and second finger inwards and upwards, until passing over the psoas muscle the external iliac artery is discovered by its pulsation. It is then to be traced upwards and inwards towards the spine, when the origin of it and the internal iliac from the common trunk will be felt. The point of the forefinger will then be nearly in the centre of a line drawn from the umbilicus to the anterior superior spine of the ilium ; and hence the necessity for an incision of six inches in length, if the artery is to be tied high up, which is to be accomplished by tracing it in a similar manner to its origin from the aorta.

If the *internal iliac* is to be tied, the operator traces it downwards from its origin, in preference to passing his finger from the external iliac artery inwards in search of it. Having placed the point of his fore finger on the vessel at the part where he intends to pass his ligature, he scratches with the nail upon and on each side of it, so as to separate it from its cellular attachments, and from the vein which accompanies but lies behind it. Thus far the operator proceeds by feeling; but it is now necessary that the sides of the wound should be separated, and kept apart by blunt spatulæ curved at the ends, so as take up as little space as possible, and not injure the peritoneum. The surgeon should if possible see the artery, and the ligature carried on the eye of a bent probe, or a convenient aneurismal needle, should be passed under it from within outwards, when it should be taken hold of with the forceps; the probe or needle should then be withdrawn, and the ligature firmly tied twice, or with a double knot. Great care must be taken to avoid every thing but the artery. The peritoneum which covers it, and the ureter which crosses it, must be particulary kept in mind. The situation of the external iliac artery and vein, which have been crossed to reach it, must be always recollected, and if there be sufficient space they should be kept out of the way, and guarded by the finger of an assistant.

The *common trunk* of the iliac arteries and the aorta itself may be tied by the same method of proceeding; the only difference which can be practised with advantage will be to make the incision a little longer at its upper part; no inconvenience arising from the addition to the length of the external wound, whilst the subsequent steps of the operation are much facilitated by it. The following method of proceeding, adopted in cases 31 and 108, will bring the method of operating so graphically before the reader that it cannot be misunderstood, and may be readily followed in operating. I began the operation, the patient lying on the back, by an incision on the fore part of the abdomen, commencing an inch and a-half below the inside of the anterior spine of the ilium, and the same distance within it, carrying it upwards, and diagonally inwards towards the edge of the rectus muscle above the umbilicus, so that the incision was between six and seven inches long. If the incision is made more outwardly, towards the side in a straight or vertical line from the ilium towards the ribs, great difficulty will be experienced in turning over the peritoneum with its contents, so as to place the finger on the last lumbar vertebra, an inconvenience which will be avoided by making the incision diagonally and of the length directed.

After dividing the common integuments, the three layers of muscles were cut through in the most careful manner; the division of the transversalis muscle was attended with some difficulty, inasmuch as there was little fascia transversalis, and the peritoneum was remarkably thin—as thin as white silver paper. On attempting to reach the under part on the inside of the ilium, so as to turn the peritoneum over, which in sound parts is always done without the least difficulty, I found that it could not be done on account of the tumor which projected inwards adhering to it, and some bleeding took place from the large veins which surrounded it, giving rise to the caution not to proceed further in that direction. At this moment, in spite of the greatest possible care that could be taken by Mr. Keate, who raised and protected the peritoneum, a very small nick was made in it, sufficient to show the intestine through it. Perceiving that I could not tie the internal iliac as I had at first intended, and that I must place the ligature on the common iliac, I tried to gain a greater extent of space upwards; but where the tendon of the transversalis muscle passes directly across from the lower ribs to aid in forming the sheath of the rectus, the peritoneum is usually so thin and so closely attached to it that it can only be separated with great difficulty. I knew this from the operation I performed in case No. 108, when, in spite of all the precaution I could then take, the peritoneum was at this spot slightly opened. It occurred in the present instance, and the right lobe of the liver was thus exposed.

The opening thus made on the fore part of the abdomen was not large enough to admit two hands. The peritoneum being however separated a little from the posterior wall of the abdomen from the outside, by the fingers, for a cutting instrument is inadmissible, four of the fingers of one hand were introduced beneath it, and it was turned a little over towards the opposite side. In doing this it must be remembered that the peritoneum must be raised, the hand being pushed towards the back as little as possible, in order to avoid getting behind the fat commonly found in that part of the body, which would lead to the under edge of the psoas muscle instead of the upper surface, and thus render the operation embarrassing.

The peritoneum being carefully drawn over with its contents, I found I could only get one hand, or a little more underneath it in search of the artery, the tumor below preventing any further detachment of the peritoneum in that direction. I therefore passed my finger across the psoas muscle, and

it rested on the fifth lumbar vertebra. The common iliac artery was not however to be felt even as high up as the fourth lumbar vertebra, nor the aorta; they had both risen with the peritoneum, and my finger resting on the spine was beneath them. Mr. Keate endeavoured to raise or draw over the peritoneum, to give me an opportunity of seeing the vessels, but this was out of the question. In doing this, he felt the pulsation of the iliac artery, which had been raised with the peritoneum, to which I found it adhering. Carefully separating it with the end of the fore finger of the right hand, I passed a single thread of strong dentists' silk, as it is termed, in a common solid aneurismal needle by the aid of the thumb and fore finger of the left hand, round the artery without seeing it. I could bring the artery a little forward by means of the aneurismal needle, when it appeared to be perfectly clear, and from the distance of the bifurcation of the aorta above, I calculated that the common iliac was tied exactly at its middle part. All pulsation below immediately ceased.

The two ends of the ligature were twisted, the peritoneum replaced in its proper situation, care being taken that the two small openings into it should be well covered under the skin, so that they might not be in the line of the incision, and that they should be covered by newly divided healthy parts, which might thus adhere to each other. Three strong sutures and three or four smaller ones were put in through the skin, in order to prevent the parts bursting asunder from the movements of the patient. This operation was only formidable, as a whole, from the circumstance, that space could not be obtained for the introduction of both hands, for, strange as it may appear, the safety of, and ease in doing the operation, depends on the first incision in the fore part of the abdomen being so large that the peritoneum containing the bowels may be freely drawn over by the expanded hands or the assistant, so that the operator can see what he is doing beneath. In case No. 107, the whole of the parts under the peritoneum could be seen distinctly, and several gentlemen not in the profession who were present, saw the common iliac artery in its natural situation. The aorta may be as readily tied by this mode of proceeding as the common iliac, and I am satisfied it is in this way such an operation ought to be performed, provided it becomes necessary to attempt it, which I suspect it will not be, for when an aneurism has been formed so high up that it prevents the application of a ligature on the side on which the disease is situated, the common iliac will be more readily tied above it, instead of the aorta, by performing the operation on the opposite or sound side of the body, for as a ligature can be applied with great ease on the sound side on the middle of the common iliac artery, it requires very little more knowledge and dexterity to pass over to the opposite or diseased side, and tie the artery above the aneurismal tumor, the size of which would have prevented the operation being done on its own or affected side. The placing a ligature on the aorta for an aneurism in the pelvis will thus be be rendered unnecessary—a most important result deduced from the operation described.

The patient suffered little or nothing from the operation, which was performed on Saturday; there was no augmentation of the pulse until Sunday evening, when it rose to 120; she then experienced some pain, which was materially diminished, although not altogether removed, by the abstraction of four teen ounces of blood. At four o'clock in the morning, Mr. Hancock, now surgeon to the Charing-cross Hospital, took away fourteen ounces more, after which she had not a bad symptom. The bowels were not moved for the first four days. The temperature of the limb diminished, but not much, which may be attributed to the method adopted in case No. 108. For the first time two persons constantly rubbed the limb night and day, and a hot brick or bottles of hot water, covered by flannel were applied to the feet, of the temperature of from 120° to 140°. One nurse rubbed the lower part of the limb, another the upper for three days and nights; if an interval of a few minutes elapsed a hot flaunel was put on the limb. The friction was very slight, so as not to injure the cuticle. The patient occasionally dozed a little, but the same gentle friction was kept up. The ligature came away on the twenty-sixth day after the operation. The external incision healed very readily, but was followed by a herniary projection, requiring the support of an abdominal bandage.

The situation of the ureter and rectum on the left side in this operation, and of the ureter and the cœcum with its appendix on the right side, should be well understood, and it should be known that the ureter rises with the peritoneum. The relative situation of the common iliac artery and vein should be particularly attended to in passing the ligature around the vessel. On the left side the artery lies external and anterior to its commencement; on the right, the artery passes over the commencement of the vena cava and the left iliac vein, which do not follow the peritoneum when drawn towards the opposite side. The bowels should be thoroughly well evacuated before the operation is performed, but purgatives should not be given for some days after it has been done. The food should be liquid, and inflammation should be subdued by leeches, general bleeding, fomentations, and opium.

The *external iliac* artery has been so often and so successfully tied that a description of the two methods of proceeding commonly adopted will suffice, with a few additional remarks. The first, recommended by Mr. Abernethy, is in accordance with the operations on the common and on the internal iliac. The patient being laid on his back, with the shoulders slightly raised, and the legs bent on the trunk, an incision is to be made about three inches and a-half in length in the direction of the artery, and terminatiug over or a little above Poupart's ligament. The aponeurosis of the external oblique muscle will be exposed, and an opening being made into it, a director is to be

introduced, and it is to be slit up to the extent of the external incision. The internal oblique and transversalis muscles, are then to be "nicked," so as to allow a director or the point of the finger to be introduced below them, when they also are to be divided, the finger separating them from the fascia transversalis and peritoneum. The fascia transversalis running from Poupart's ligament to the peritoneum is now to be torn through with the nail, immediately over the pulsating artery, and the peritoneum is to be separated by the finger and pushed upwards until sufficient room is obtained; which, in this as well as in all other operations on the iliac arteries, is sometimes difficult on account of the protrusion of the intestines covered by the peritoneum, when the patient is not sufficiently tranquil. The artery is yet at some depth, and covered by a dense cellular membrane, connecting it to the vein on its inside, and which must be torn through with the nail. The anterior crural nerve is separated from the artery by the psoas muscle, at the outer edge of which it lies. The aneurismal needle should be passed between the vein and the artery, and the point made to appear on the outside of the artery.

In this operation the ligature is placed on the external iliac, above where it gives off the epigastric and circumflexa ilii arteries; and as the operation is very much the same as that already described, with the exception of the incision being shorter and nearer to Poupart's ligament; it is obvious if it were found necessary from disease to tie the artery higher up, or even to tie the common iliac, that it might be done by merely enlarging the wound.

Another method has been recommended by Sir Astley Cooper, which is perhaps more followed where there is little doubt of the artery being sound. It offers the advantage of greater space, which enables the surgeon to see better what he is doing; but it does not so readily admit of the artery being tied high up, without the incision being extended upwards, so as to give more room for the introduction of the hand behind the peritoneum.

"The patient being placed in the recumbent posture, on a table of convenient height, the incision is to be begun within an inch of the anterior superior spinous process of the ilium, and is to be extended downwards in a semicircular direction to the upper edge of Poupart's ligament. This incision exposes the tendon of the external oblique muscle: in the same direction the above tendon is to be cut through, and the lower edges of the internal oblique and transversalis abdominis muscles are exposed; the centre of these muscles is then to be raised from Poupart's ligament; the opening by which the spermatic cord quits the abdomen is thus exposed, and the finger passed through this space is directly applied upon the iliac artery, above the origin of the epigastric and circumflexa ilii arteries. The iliac artery is placed upon the outer side of the vein; and the next step in the operation consists in gently separating the vein from the artery by the extremity of a director, or by the end of the finger. The solid curved aneurismal needle is then passed under the artery, and between it and the vein from without inwards, carrying a ligature, which being brought out at the wound, the needle is withdrawn, and the ligature is then tied around the artery, as in the operation for popliteal aneurism. One end of the ligature being cut away, the other is suspended from the wound, the edges of which are brought together by adhesive plaster, and the wound is treated as any other containing a ligature."

This method of operating will suffice when the artery is to be tied for an aneurism which does not extend as high as Poupart's ligament. When it does, the operator will be so much inconvenienced by it, whilst the sound part of the artery above the tumor will be so much in a hollow behind it in the pelvis, that a ligature will not readily be passed around it, and the disturbance to the peritoneum will be much greater, and much more likely to give rise to peritonitis, than if the incision were made an inch longer on the face of the abdomen. The surgeon, instead of searching for the artery, as Sir Astley Cooper has directed, through the passage by which the spermatic cord quits the abdomen, and thus passing the fingers directly under the peritoneum, will find it very much for his own ease, and for the advantage of his patient, to pass his fingers under the peritoneum from the inside of the wall of the ilium, from which it readily separates, and thus approach the artery from the outside, instead of from below. He will obtain more room, reach the artery easily above the origin of the circumflexa ilii, and avoid that disturbance of the peritoneum, in applying the ligature, which often leads to inflammation.

If the surgeon has unluckily divided the epigastric artery, either in this or any other operation, all that he has to do is to enlarge the incision, and tie both the divided ends; and I have no hesitation in saying, it will not be of any consequence, either in this operation or in one for hernia.

Of the Operation of placing a Ligature on the Gluteal or Sciatic Arteries.

In all cases of aneurism of the gluteal and sciatic arteries, the internal iliac artery should be tied, instead of an operation on the part itself. In all cases of wounds of arteries which are the only ones rendering an operation for placing a ligature on these vessels necessary, the wound should in a great measure regulate the course of the incision. The operation is an act of simple dissection, first, through the common integuments for the space of four or five inches, then through and between the fibres of the glutæus muscle to the same extent; a dense aponeurosis covering the vessels is to be next divided, when the bleeding will lead to the injured vessel. In the dissecting-room the operation is described as follows:—Place the body on the face, turn the toes inwards; commence the incision one

inch below the posterior spinous process, and one inch from the sacrum, carry it on towards the great trochanter in an oblique direction to the extent of four or five inches, divide the gluteus muscle and the aponeurosis beneath it, and seek for the artery as it escapes through the upper and anterior part of the sciatic notch and lying close to the bone. If the vessels of the gluteus muscle bleed, so as to be troublesome, and cannot be stopped by compression, they must be secured.

If the sciatic artery be the vessel injured, the incision should be made in the same direction, but about an inch and a half lower down; if the course of the wound renders it doubtful which artery is wounded, the incision should be as nearly as possible between the two lines directed, the wound being always the best guide; and care should be taken in every instance to include nothing in the ligature but the artery.

Of the Operations on the Femoral Artery.

Compression should never be made on an artery on which a ligature is about to be placed; because the pulsation is thereby suppressed, and the most important guide to the vessel is at the same time taken away. Where the artery is wounded and bleeding, compression must be had recourse to in the first instance to arrest it; and the first incisions must be made without the information which the pulsation gives as to the precise situation of the artery, although the finger may be allowed to rest on the part, underneath which the artery could be felt before the pressure was applied. The external incision should always be made longer or shorter in proportion to the depth at which the artery is situated. It should be at least one-third longer in the middle than at the upper part of the thigh; and whilst a long incision always facilitates the subsequent steps of the operation, it never does harm, unless it is out of all reasonable proportion. The centre of the incision should be if possible directly over that part of the artery on which it is intended to apply the ligature; but no inconvenience will arise from its being applied nearer its upper extremity. The patient being laid on his back, and properly supported, the knee is to be bent and turned outwards, by which the head of the femur will be rolled in the acetabulum, and the femoral artery will be more distinctly felt at the upper part lying on the psoas muscle, having the vein to the inside of it, and the anterior crural nerve about half an inch on its outside, passing between the psoas and iliacus muscles, although some branches soon approach the artery, and run down on the external part of the sheath. The relative position of the parts being duly considered, an incision is to be made directly in a line over the pulsating artery, and carried through the skin, cellular tissue, and superficial fascia, down to the deep-seated, or fascia lata of the thigh. If an absorbent gland should be in the way, it must be turned aside or removed. The arteria profunda femoris is given off about two inches below Poupart's ligament, on the back part and outside, whilst three or four small vessels spring from half an inch to an inch below it on the forepart, and one or other of these may be divided. They are the superficial epigastric, the superficial pudic, the superficial circumflex of the ilium, and probably an artery supplying the absorbent glands. If they bleed so as to be troublesome they must be secured, more particularly if the femoral artery is to be tied below them. The fascia lata is now to be divided, with that part of the fascia transversalis, which descending beneath Poupart's ligament forms the sheath of the artery, when the vessel will be exposed. In dividing this fascia and sheath, the point of the knife is always to be directed to the centre of the artery, so that if it be cut by accident it may be seen, when the only result will be the necessity for the application of a ligature above, and one below it. The artery being fully exposed, as ascertained by the pulsation being felt by the finger, it is to be separated from its cellular attachment to the sheath on each side by a blunt or silver knife; and the aneurismal needle or probe, armed with a strong single thread of dentists' silk, is to be passed under it from the inner or pubic side outwards, by which all injury to the vein from the round point of the needle or probe will be avoided. Two common knots are to be made in the usual manner, when one thread may be cut off, or the two twisted together and brought carefully out of the wound; the edges of which are then to be duly approximated and retained in that situation by sticking plaster and a moderate compress, secured in a similar manner. The knee is to be bent forward to relax the parts, and laid on the outside with a pillow underneath it.

The needle will pass more easily under the artery if the thigh is bent on the trunk; and before the knots are tied, the surgeon should ascertain that pressure on the part or artery which he has nearly surrounded by the ligature, suppresses the pulsation in the tumor below.

The operation for popliteal aneurism lower down in the thigh is to be done in the following manner:—

The surgeon having turned the knee outwards, and bent the leg inwards into the tailor's sitting position, to show the course of the sartorius muscle, should trace the artery from the groin downwards, until it appears to pass under that muscle. The external incision, four inches in length, made in the course of the artery, should pass over this point one inch, so that when the fascia lata is divided, the sartorius muscle may be seen crossing over to the inside at the lower extremity of the wound. The fascia lata is to be divided for the space of two inches of the incision upwards. The fore-finger is then to be introduced into the wound, and pressure made with it rather outwardly, when it will readily distinguish the pulsation of the artery, still included in its sheath. This is to be opened by slight and repeated touches of the knife directly over the centre of the line of the vessel, or it may be divided on the director,

when the artery will be exposed. The point of the fore-finger will easily recognise it from the roundness and firmness of the feeling communicated by it as well as by its pulsation, and the end of the nail, or handle of the scalpel or blunt knife, will separate it with facility from its attachments, to such an extent as will admit the blunt point of the solid unyielding aneurism needle to be passed beneath it from the pubic side. If the point of the needle does not readily come through the cellular attachments of the artery on the outside, this part must be touched lightly with the scalpel, or rubbed with the nail until the ligature is exposed, which should then be taken hold of with the forceps, and one end drawn out, whilst the instrument with the other end is withdrawn. The operator, taking both ends of the ligature, which has been in this manner passed under the artery, between the fingers of one hand, presses upon the artery with the fore-finger of the other, so as to arrest the course of the blood in it, when if there be an aneurism below, the pulsation in it will cease. The ligature is then to be pressed upwards as far as the artery has been detached, and is to be tied with a double knot. The wound is to be dressed as in the previous case by adhesive plaster and compress, but without a bandage; and the patient is to be placed in bed, with his knee bent forward, or resting on the outside if more agreeable to him.

The operation is done in this manner on that part of the femoral artery which is not covered by muscle, and all interference with the sartorius is avoided. It is the improvement on the Hunterian operation recommended by Scarpa, and ought always to be adopted. This method obviates all discussion as to placing the ligature on the outside of the sartorius muscle, or to the fear of injuring the absorbents; and as to the saphena vein, it can always be seen, and its course traced up the thigh and avoided. After the first incision is made and completed down to the fascia lata, that part is to be divided, I have said for the length of two inches, but this must be dependent on circumstances; the object being to obtain a view of the sheath containing the artery, the opening into which after the first touch of the knife may be completed with the assistance of the director underneath it; and the artery will be less disturbed in its lateral attachments by an opening into the sheath of three quarters or an inch in length, than by one of half the extent, as it will admit of the aneurism needle being passed under it with more facility, and consequently with less disturbance to the surrounding parts. I have never had reason to believe that a free opening into the fascia of the thigh has done mischief, or even into the sheath, provided the artery has not been unnecessarily disturbed.

The warmth of the limb operated upon should be maintained by gentle friction from the toes upwards to the knee, and when left at rest it should be enveloped in flannel. The wound should not be dressed until the fourth day, the limb being kept quite quiet; the patient should move as little as possible in bed, and the part of the heel on which it rests should be examined from time to time, as it may under pressure become gangrenous.

Suppression of the secretion of urine is not uncommon during the first twenty-four hours, and will be gradually removed by the patient's taking mild diluent drinks. The constitutional irritation in all these operations is frequently great, the pulse rising in forty-eight hours from eighty-five to one hundred and twenty; and if this continues until the third day, when the fear of mortification will have subsided, it should be moderated by the abstraction of a small quantity of blood. In cases of this kind I have had occasion to bleed twice, and with the happiest effect, the pulse having fallen in consequence to its natural standard. The medicines given at the same time were saline draughts every six hours, with four drops of Battley's solution of opium. The ligatures came away on and about the fifteenth day. In many cases they remain a much longer time without inconvenience.

LECTURE IX.

The operations on the posterior tibial and peroneal arteries; The operations on the anterior tibial artery; The operations on the carotid artery; The operations on the arteria innominata and the subclavian artery; The operations on the axillary artery; The operations on the brachial artery; The operations on the ulnar artery; The operations on the radial artery.

On the Operations on the Posterior Tibial and Peroneal Arteries.

The posterior tibial artery may require to be tied between the ankle and the heel. In this situation its pulsation may be felt, and will be the best guide to the artery. It has the tendons of the tibialis anticus, and of the flexor digitorum communis, nearer to the malleolus than itself, and distant about a quarter of an inch; there is a vein on each side of the artery. Posterior to this is the posterior tibial nerve, and nearer the heel the tendon of the flexor longus pollicis; a little below this part the artery divides into the external and internal plantar arteries. To tie the artery near the heel, its pulsation should be felt, and an incision about two inches long made upon it, through the common integuments and superficial fascia; a strong aponeurosis will be found beneath, covering the sheath of the vessels and adhering to the tendons. This aponeurosis must be carefully opened, and then the sheath of the vessels: the artery should be tied with a single ligature. The nerve is nearer the heel.

The posterior tibial artery may be tied a couple of inches higher up in the small part of the leg, by making the incision on the tibial edge of the soleus muscle, under which it lies; but in the middle or calf of the leg, a different operation should be performed for the purpose of placing two ligatures upon it in a case of wound. The old method, and that which I have recommended, have been sufficiently contrasted in pages 35 to 38, to which I now refer. The first incision, six inches long, should be made nearer to the inner edge of the leg than to the centre, and should be carried through the gastrocnemius muscle, plantaris tendon, and soleus muscle, down to the fascia, under which the artery lies with its accompanying veins, having the posterior tibial nerve to the fibular side of it. If the incision has been made in the upper part of the calf of the leg, the peroneal artery will be exposed by it; but if the peroneal artery be the vessel injured, the incision should be made towards the fibular side of the leg; and when the surgeon divides the fascia he will find this artery covered by the fleshy fibres of the flexor longus pollicis muscle, at any distance below three inches and a half from the head of the fibula; which fibres must be divided, when the artery will be found close to the inside of the bone. Above that part the artery is under the fascia, and upon the tibialis posticus muscle. It has not an accompanying nerve. Both arteries will be readily found, by either of the incisions described, if the surgeon is acquainted with their situation.

On the Operations on the Anterior Tibial Artery.

The anterior tibial artery is to be tied at that point of its course in which it may be wounded. When the operation is done for aneurism, it should be performed a short distance above the tumor, and sometimes a second operation below it will become necessary. If the aneurism should be situated so high up, and so close to the origin of the vessel, as not to admit of a ligature being applied anterior to the interosseous ligament, it may be placed on the femoral artery in the thigh, and the result awaited. If it appeared likely to succeed at first, and that the pulsation returned slowly, the artery should be tied below the tumour, because the return of pulsation would probably depend on the blood regurgitating into the vessel; or a ligature may be placed in the first instance upon the trunk of the popliteal artery above where the anterior tibial is given off, by the same operation as is recommended for the ligature of the posterior tibial, the incision being begun a little higher up.

In order to tie the anterior tibial artery near to its passage from the back to the fore part of the leg, after it passes into the interosseous space and over the interosseous ligament, and for one-third of its descent towards the instep; draw a line from the head of the fibula to the base of the great toe, which will nearly describe its course. An incision four inches in length is to be made in this line down to the fascia covering the muscles; and if the foot be bent upwards and again extended, the bellies of the tibialis anticus and extensor digitorum communis muscles will be more distinctly seen. The fascia is to be divided for the whole length of the incision between them; and they are then to be separated for the same distance by the scalpel and the finger; the artery will be found

close on the interosseous ligament, between its two venæ comites.

In the middle third of the leg, the origin of the extensor proprius pollicis intervenes between the tibialis anticus and extensor communis digitorum muscles. The anterior tibial nerve, a branch of the peroneal, attaches itself to the artery a little above this middle part, and is usually found in front of it, although it is not constantly in that situation: care should always be taken to avoid it.

In the inferior part of the leg, the artery lies on the tibia, having the tendons of the extensor digitorum communis on the outside, that of the extensor proprius pollicis on the inside, by which it is overlapped, being also covered by the fascia and the integuments.

On the instep this artery runs over the astragalus, the naviculare, and the os cuneiforme internum, to the base of the metacarpal bone supporting the great toe. It here divides into two branches, one dips down between the first and second metatarsal bones, to join the terminating branch of the external plantar artery; the other passes on to the inside of the great, and the opposite sides of the first and second toes. The artery is always to be found on the fibular side of the tendon of the extensor proprius pollicis.

On the Operations on the Carotid Artery.

The carotid artery may be tied in almost any part of its course, and in the following way:—The patient being seated with the shoulders supported, in such a manner that the light may fall on the neck, the head is to be bent a little forwards, to relax the muscles on the fore part. An incision is then to be made on the line of the inner edge of the sterno-cleido-mastoideus muscle, by which the integuments, the platysma myoides, and superficial cervical fascia are to be divided. The extent of this incision, in persons with long necks, may be from a line parallel with the cricoid cartilage to about half an inch of the sternal end of the clavicle: when the neck is very short, it must be begun as high up as the lower edge of the thyroid cartilage, so as to be as nearly as possible three inches in length. The sterno-cleido-mastoideus muscle is then to be drawn outwards, with any vein which may be seen attached to its under edge. The pulsation of the artery will point out its situation, and the sterno-hyoideus and sterno-thyroideus muscles being drawn and kept inwards, the omo-hyoideus will be seen crossing in the upper part of the hollow thus formed by the separation of these parts. The central tendinous portion of this muscle is attached and fixed by the deep cervical fascia, and lies immediately over the sheath of the vessels, and particularly over the jugular vein. This fascia, which is strong although thin, is to be carefully divided below the muscle, and immediately over the centre of the artery, the position of which is to be accurately ascertained by the finger. At or beneath the same spot, the sheath of the artery is to be opened; and the long thin nerve, the descendens noni, which runs upon the sheath, will at this part be seen inclining to the tracheal side of the artery. It is to be separated and drawn inwards with the muscles. If the sheath of the artery be carefully opened immediately over its centre, the jugular vein will scarcely interfere with it. But as it has been known to enlarge suddenly under the exertions or excitement of the patient, so as to overlap the artery, it has been recommended to make gentle pressure on the vessel at the upper part of the incision, and below if necessary, in order to prevent this occurrence. The aneurismal needle is then to be introduced and passed under the artery from without inwards, by which the jugular vein and the par vagum nerve will be avoided, more particularly if the sheath of the vessels has been undisturbed, save where it has been opened immediately over the artery. The point of the aneurismal needle is to be brought out close to the inside of the artery and within its sheath, by which means all danger will be avoided of injuring either the recurrent or sympathetic nerves which lie behind or to the inside of it. As to the œsophagus, thoracic duct, or thyroid artery, they are not likely to be injured by any common operator; but he should be aware, that on the left side, if he is obliged to operate low down, he may meet with greater inconvenience from the jugular vein, which is more anterior to the artery, and rather overlaps it, whilst on the right side it inclines outwards from it.

The carotid artery may be tied higher up in the following manner:—The incision in this instance should terminate a little below where the former one begins, and must of course proceed upwards for the same length of three inches, in a line extending towards the angle of the jaw. The head should be laid back to enable this to be done, and ought to be kept in that position by an assistant. The artery at this part of the neck is covered by the integuments, the platysma myoides muscle, and the fascia. After the muscle has been divided, the strong fascia must be carefully raised by the forceps and opened, and the operator will do wisely in dividing it upwards and downwards on the director. With the end of the scalpel or a blunt knife he should separate the cellular texture from the veins, which appear in this situation, and are often the source of much embarrassment. The sheath of the artery is to be opened over the centre of the vessel, and the ligature is to be passed around it as before. The descendens noni nerve runs in general on the outside of the artery in this part of the neck, and afterwards crosses over to the tracheal side. The par vagum, which lies in the angle formed posteriorly by the apposition of the carotid artery and jugular vein, and to which latter it is more particularly attached, is to be avoided on introducing the aneurismal needle; and on bringing it out on the inside, the same attention must be paid to prevent injury to the great sympathetic or any of its branches. The surgeon in both these operations should draw the ligature first a little outwards and

then inwards, so as to enable him to ascertain that he has included nothing in it but the artery, which is to be tied with two knots; one end may be cut off, or both may be twisted together, and brought out of the wound opposite where the vessel has been tied. The integuments should be accurately closed by adhesive plasters, and the patient put to bed with the head bent forwards, and properly supported. He should eat as little solid food as possible until after the ligature has come away; and observe even greater precautions as to quietude than in other instances, especially if the operation has been done for a wound of a branch which cannot be exposed.

The external carotid artery may be tied by an operation conducted in a similar manner. After the first incisions have been made, and the strong cervical fascia divided, the operator must feel for the pulsating vessel, which will be found on a line parallel with the cornu of the os hyoides, below which part the common trunk usually divides into the external and internal carotids, the external being the more superficial and internal of the two at their origin. The external carotid turns with its convexity inwards; and nearly opposite but rather above the os hyoides it is crossed by the ninth or lingual nerve, the digastric and stylo-hyoid muscles, and it is below this part it should be tied. Whenever the external carotid is secured by ligature, on account of a wound of a part which cannot be reached, the ligature should be applied near to its origin, that is, immediately below where the superior thyroid artery is given off, and without fear of evil occurring from the vicinity of it or of the internal carotid.

When any of the branches of the external carotid are wounded, they ought to be tied if possible at both ends, and at the part wounded. If this cannot be done, and the hemorrhage demands it, the external carotid is the vessel on which the ligature should be placed; for by cutting off at the same time as many as possible of the anastomosing arteries, a better chance is given for the closing of the injured part of the vessel.

On the Operations on the Arteria Innominata, and on the Subclavian Artery.

The arteria innominata arises from the upper part of the arch of the aorta, generally on a line nearly parallel with the upper edge of the cartilage of the second rib, ascends obliquely towards the right side, and usually divides opposite the sterno-clavicular articulation into the right subclavian and the right carotid arteries; the last of which appears to be its continuation, although the smallest in size. The arteria innominata is about two inches in length, rarely exceeding two inches and a-half, although it is very variable both in length and situation, so much so as to sometimes render the operation of placing a ligature upon it during life impracticable. It is covered by the right vena innominata, which receives the left at a right angle, near the origin of the artery. Exterior to the vena innominata are the sterno-thyroideus and sterno-hyoideus muscles, some strong fascia covering the vein at its upper part, and the first bone of the sternum. The arteria innominata may ascend higher in the neck before it divides, in which case its pulsation will be perceptible in front of the trachea, and the subclavian artery will cross higher in the neck, which is one reason for not continuing the external incision down to the sterno-clavicular articulation in the operation on the right carotid. The subclavian artery, given off behind or a little above the articulation, proceeds outwardly for the space of one inch before it reaches the inner edge of the scalenus anticus muscle, which is about half an inch in width; so that the subclavian artery, when it clears the outer edge of the scalenus anticus muscle in a tall man, is not more than one inch and a-half or three-quarters from its origin, even to the spot at which a ligature is usually placed upon it. The first branch given off is the vertebral on the upper and back part of the artery, and distant from the carotid at the bifurcation half an inch. The thyroid axis is given off at the anterior and upper part of the artery, a quarter of an inch more outwardly, and the internal mammary often arises directly opposite from the anterior and inferior part of the artery, descending into the chest behind the junction of the first and second ribs with their cartilages. The inner edge of the scalenus anticus muscle is close to these two last vessels. The phrenic nerve crossing this muscle obliquely lies on the outside of the thyroid axis, and on the inside of the internal mammary artery; having crossed the subclavian artery at this part, it descends between it and the junction of the internal jugular and subclavian veins to the chest. Internal to this, some small branches of the great sympathetic nerve, which lies itself behind, pass over the artery; and still more internal, but distant about a quarter of an inch from the carotid artery, the par vagum crosses likewise. The only point at which the subclavian artery can be tied internal to the edge of the scalenus anticus muscle is at this point, on the inside of the par vagum, and in a space scarcely more than one quarter of an inch in width, to which the carotid will be the best guide. It appears to me that a ligature may be as readily and as safely applied around the innominata immediately below its bifurcation, as around the subclavian close to the same spot, although little reliance can be placed on success attending either operation.

From this view of the parts it will be evident, that the operation may be most advantageously done in the following manner. Raise the shoulders of the patient, and allow the head to fall backwards, by which the artery will be drawn a little from within the chest. Let an incision be made over and down to the sterno-cleido-mastoideus muscle, the sternal origin of which, and nearly the whole of the clavicular origin, should be divided on a director, carefully introduced below it, avoiding some small veins which run below and parallel with its origin. An incision is now or previously to be made two inches in length along the inner edge of the muscle, which

will admit of its being raised and turned upwards and outwards. Some cellular texture being torn through, the sterno-hyoideus-muscle is brought into view, and should be divided on a director. The sterno-thyroideus is then to be cut through in a similar manner. A strong fascia and some cellular texture here cover the artery, having the nerves above mentioned running beneath it, the carotid being to the inside, the internal jugular vein to the outside. By following the carotid downwards, the finger will rest on the innominata and on the origin of the subclavian, and a ligature may be placed on either. If on the innominata, the aneurismal needle, and several kinds should be at hand, should be passed from without inwards, immediately below the bifurcation, and close to the vessel. If on the subclavian, the surgeon must recollect, that there is only about a quarter of an inch of this artery on which the ligature can be applied; this small space being bounded internally by the carotid artery, and externally by the par vagum above, and the vertebral artery below. The ligature should be applied close to the vertebral artery, the needle being passed from below upwards; the greatest care being taken to avoid the recurrent nerve, which separates from the par vagum at this part, and winds under the subclavian and carotid arteries, to be continued upwards to the larynx. If the ligature be placed on the arteria innominata, the same care must be taken to draw the par vagum outwards, and to avoid the recurrent nerve. The edges of the wound should be brought together and dressed in the usual manner; the head being bent forwards on the trunk, and maintained in that position in order to relax the parts, and admit of their being kept in apposition.

This operation ought only to be performed in cases of ancurism of the subclavian artery, in which it is presumed that the disease extends as far as the external edge of the scalenus anticus muscle, but not more inwardly. The arteria innominata has been certainly tied five, if not six, times in vain, and in two or three other instances the attempt failed, the operator not succeeding in his object. In Dr. Mott's case the ligature came away on the fourteenth day, but the patient died from hemorrhage, the consequence of ulceration of the artery, on the twenty-sixth day after the operation. Dr. Graefe's patient also died from hemorrhage on the sixty-seventh day. It is evident from these cases, that a man may live so long after the operation as to show that he does not die from the immediate effects of it, or from any that must necessarily take place. It is therefore possible, that if the operation be often repeated it may eventually be successful.

The left subclavian artery rises perpendicularly out of the chest like the innominata, but on a plane much posterior to it, so that at the part where the vertebral artery is given off, and which is about an inch and a half from the origin of the artery, it lies nearly an inch deeper from the surface than the vessel on the opposite side. It is covered by, or is more directly connected with, the important parts which are also in the vicinity of the right subclavian. The pleura adheres to it, can scarcely avoid being torn in putting a ligature around it. The par vagum is parallel and anterior to it. The internal jugular vein and the left vena innominata lie over it. The thoracic duct and œsophagus are connected with it; and the carotid artery is in front. So that with the most careful dissection it is not a very easy matter to place a ligature upon the ascending portion of the left subclavian artery, without doing more mischief than is compatible with the life of the patient.

Aneurisms of the arch of the aorta have been sometimes known to appear so far beyond the outer edge of the scalenus anticus muscle, as to impress the surgeon with the idea that they arose from the subclavian artery, and that an operation on that vessel might be attended with success. This error is not likely however to occur in the present day; the stethoscope will always point out the existence of such an ancurism within the chest, and will therefore demonstrate the impropriety of the operation. Aneurisms of this nature are usually attended by some circumstances indicating their more internal origin, independently of the information derived from the stethoscope; but an operation should only be attempted when the case is free from doubt.

Whenever an aneurismal tumor in the neck is accompanied by any alteration of the sterno-clavicular articulation, the case is clearly one totally unfitted for any operation. The same may be said of any case of aneurismal swelling, either internal or external to it, in which the stethoscope applied on the sternum in the course of the arteria innominata, or of the arch of the aorta, indicates disease. A swelling at the root of the carotid is more likely to be an aneurism of the arch of the aorta, or of the arteria innominata, than of the carotid itself, and the stethoscope will remove all doubt.

The subclavian artery has been frequently tied above the clavicle, and *external* to the scalenus anticus muscle. It should be done in the following manner. The patient being placed horizontally on the table, in such a situation that the light may be directed into the hollow in the bottom of which the artery is to be tied, the shoulder is to be depressed, and an incision made along the edge of the clavicle, commencing one inch nearer the sternum than the clavicular edge of the sterno-cleido-mastoideus muscle, and carried outwards to the extent of three inches and a half or four inches. The platysma myoides and superficial fascia are to be divided, taking care not to injure the external jugular vein, which should be drawn to the outer side of the wound. By this incision the edges of the trapezius and sterno-cleido-mastoideus muscles will be exposed.

The object of the operation is in the first instance to reach the outer edge of the anterior scalenus muscle: this lies immediately below the outer edge of the clavicular portion of the sterno-cleido-mas-

toideus, and the division of a portion of this part of the muscle will greatly facilitate the subsequent steps of the operation, although it may be done without it. The artery will be found crossing over the first rib at the very edge of the attachment of the scalenus anticus to it; but a quantity of cellular substance and fascia intervene, which must be torn through before it can be exposed. This should be done with a blunt round-pointed knife, in a line parallel with the first incision, but more immediately over the outer edge of the scalenus muscle. The omo-hyoideus muscle passing obliquely across the root of the neck will be in this manner exposed, which should be clearly done, because it narrows the space in which the operation is to be performed to a small triangle, the outside and apex of which is formed by this muscle, the inside by the scalenus anticus, the base by the rib, above it the subclavian vein, and above it again, but under the clavicle, the supra-scapular artery and vein. The blunt knife working in the triangular space, will first expose one or more of the nerves of the axillary plexus, which again diminishes the space; more inwardly the scalenus anticus will be felt, and should be seen by tearing through the thin fascia which lies behind the omo-hyoideus and is connected with it. The point of the finger, assisted if necessary by the blunt knife, should be passed along the edge of the muscle until it rests on the first rib, and at the angle formed between the muscle and the rib the artery will be found and known by its pulsation. The operator should detach the artery in a slight degree from its connections with the point of the nail, and the aneurismal needle should be passed in preference from below upwards, by which the pleura will be avoided. After the ligature has been passed under the artery, the vessel should be pressed upon with the point of the finger, whilst the ligature is firmly held in the other hand, by which the circulation through the artery will be stopped, and the pulsation in the tumor and at the wrist will cease, when the ligature may be tied with a double knot; and for doing this one or two steel probes having a ring at the end of each, placed at a right angle with the shaft, will afford great assistance.

In some instances, and particularly in short-necked persons, the omo-hyoideus lies close to the clavicle, and requires to be drawn upwards and outwards from it. In others, the lowest nerve of the axillary plexus lies over the artery, and may be mistaken for it. When the veins coming from the neck are large and numerous, great care must be taken to avoid injuring them, as they frequently cause, not only much hemorrhage, but great delay. Great care must be also taken in all these operations to prevent the ingress of air into any of the veins which may by accident be opened, as its admission in quantity has occasioned sudden death, although the entrance of a few bubbles may not be so dangerous as has been supposed.

On the Operations on the Axillary Artery.

The patient being firmly supported or placed in the horizontal position, the arm is to be slightly separated from the body, and an incision is to be made in the course of the axillary artery, through the integuments, superficial fascia, and great pectoral muscle, in fact through the anterior fold of the armpit. The length of the incision will depend on the part at which the artery is to be secured. It may begin however, as a general rule, near that part where the pectoral muscle first touches the deltoid. The parts divided being separated, the pectoralis minor will be seen crossing at the upper part of the wound to the coracoid process, and the artery may be felt below it, enclosed in its cellular sheath, with the nerves of the arm and its venæ comites.

At the lower edge of the pectoralis minor, the artery is crossed by the outer of the venæ comites, which passes between the external cutaneous and the external origin of the median nerve, at the spot where they separate from the plexus. The artery may be tied below this separation, or the nerves and vein may be drawn to the outside, and the artery tied above the union of the external with the internal root of the median nerve and as high as the origin of the arteria thoracica acromialis, the pectoralis minor being either raised and pushed upwards, or divided. The internal root of the median nerve is in connection with the internal cutaneous and ulnar nerves; the larger of the venæ comites is to the inside and behind, but as it ascends it receives its fellow, and with the cephalic vein forms in front of the artery the subclavian vein.

On the Operations on the Brachial Artery.

The brachial artery can be traced by its pulsation from the lower edge of the teres major muscle to below the bend of the arm, where it is covered by the pronator radii teres muscle. At first it is to the ulnar side of the humerus, resting on the triceps, and slightly overlapped by the coraco-brachialis and biceps muscles. In the middle of the arm it rests on the tendon of the coraco-brachialis, is close to the bone, and lies under the lower edge of the biceps; in which situation it may always be compressed by bending the forearm, so as to cause the belly of the biceps to enlarge, when pressure made immediately below it will arrest the circulation in the brachial artery. It then crosses towards the anterior part of the arm and rests on the brachialis anticus muscle until it passes the bend of the elbow. It is accompanied by two veins, which are connected to it by a loose cellular membrane forming a sheath. The external cutaneous and median nerves lie a little to the outside of the artery at the upper third of the arm. In the middle third the median nerve lies generally in front of, but sometimes between the artery and the bone, and is on the inside at the inferior part. The internal cutaneous nerve runs parallel but superficial to the artery, the ulnar nerve nearer but posterior to it. When a ligature is to be placed on

the brachial artery in the upper part of its course, the incision should be made about three inches in length, and directly on the line of the pulsating vessel, by which all mistakes will be avoided. The integuments should be divided carefully, that the internal cutaneous nerve may not be injured; the fascia is then to be cut through and the forearm bent, when the vessels and nerves will be relaxed. The artery is to be separated from its veins, one on each side; and it must be recollected that the external cutaneous and median nerves are to the radial side of the artery, the internal cutaneous and the ulnar nerves to the ulnar side of it. In the middle of the arm the median nerve lies immediately over the artery, except in cases where it passes behind it, and when it lies in front it may be mistaken for the artery, from the pulsation being communicated to it. The incision should be to the same extent of three inches, directly in the course of the artery, and the ligature should be passed from the ulnar to the radial side of the vessel, in order to avoid the possibility of including either the internal cutaneous or the ulnar nerve, and for the purpose of excluding both the veins.

On the Operations on the Ulnar Artery.

The ulnar artery may be tied near the wrist, where it is most superficial. Bend the wrist, so as to make the flexor carpi ulnaris act, when the tendon will be felt internal to the styloid process of the ulna; make an incision two inches and a-half in extent along the radial edge of this tendon, dividing the fascia of the arm which covers it. The artery will be felt below the deep-seated fascia, and on dividing it will be seen with its venæ comites, the ulnar nerve being behind it, and which must be avoided in the application of a ligature. In the palm of the hand, the ulnar artery having passed over the annular ligament of the wrist, is covered by the integuments and the palmar aponeurosis. To tie the ulnar artery in the *middle third* of the arm, the surgeon should bend the wrist, and trace upwards the tendon of the flexor carpi ulnaris as far as it can be felt. At the point where it becomes indistinct an incision should be commenced and carried upwards for the space of four inches; the fascia is then to be divided for the same extent, when the flexor carpi ulnaris may readily be traced upwards by its tendon, which is on the radial side of it; this muscle may then be easily separated from the flexor sublimis, beneath the edge of which the artery will be found covered by the deep-seated fascia, having a vein on each side, and the ulnar nerve to the ulnar side of it. By this method of proceeding the artery will be readily exposed, which is not always the case by any other manner of operating, and it may be tied as high up as where it passes from under the flexors of the arm. It can only be necessary to tie the ulnar artery in the upper third of the arm in consequence of a wound; and in this situation it has been considered impracticable to do it. It may however always be done, and without much difficulty.

The brachial artery, a little below the bend of the arm, divides into the radial and ulnar arteries, the radial being the continuation of the brachial in direction, the ulnar in size. The brachial artery, at the bend of the arm, is cushioned on the brachialis internus muscle, having the tendon of the biceps on the outside, the median nerve on its inside, which is at first continued on the same side of the ulnar artery; but as that vessel inclines towards the ulna for about an inch, and then passes between the two origins of the pronator radii teres muscle, the median nerve crosses it at this part to get into the middle of the arm, and is then separated from it by the ulnar origin of the muscle. The artery continues its course, inclining outwardly, under the pronator radii teres, the flexor carpi radialis, the palmaris longus, and the flexor sublimis muscles, lying on the flexor profundus. On clearing the ulnar edge of the flexor sublimis, it is covered by the flexor carpi ulnaris; and at this part it may be tied by the preceding operation, the course of the artery having been obliquely under these muscles for the extent of two inches. To tie it in any part of this course, they must be more or less divided, and the only difficulty or danger arises from the median nerve, which lies deeper under the radial origin of the pronator teres. But the whole of the muscular fibres may be divided without injuring the nerve, by successive and careful incisions through them until the artery and nerve are exposed, and a ligature may then be applied above and below the wound in the vessel. It may be supposed by way of elucidation, that a man has received a wound from a sword through the flexor muscles, which injures also the ulnar artery, as may be presumed from its situation, and the continued and impetuous flow of blood. It shall be further supposed, that this wound is in a slanting direction from the ulna towards the radius. The surgeon may, if he thinks he can calculate the point at which the artery is injured, cut down upon it in the direction of the fibres of the intervening muscles, and even through them until he reaches the artery; but if he has erred in his calculation he must introduce a probe, and after having ascertained the line the wound has taken, he should cut if necessary across the muscular fibres in that direction until he exposes the bleeding artery, and if he is careful not to divide the median nerve, no inconvenience will arise from the operation.

If the ulnar artery is wounded near its origin, and through the radial side of the pronator teres muscle, an incision should be made through the integuments and the aponeurosis of the biceps muscle; the pronator muscle being then laid bare, it is to be drawn inwards and downwards or towards the ulna, and the dissection continued until the median nerve is exposed. The probe introduced through the original wound will lead to the artery, the pulsation of which will be felt and the bleeding seen. Where the nerve crosses the artery, the vessel will be found above to the radial side of it, and to the ulnar side below. It may be tied above without dividing a muscular

fibre; but at the part where the nerve crosses and below it, some fibres of the pronator teres must be divided, and in some cases the whole of them, before the artery can be properly secured by two ligatures.

On the Operations on the Radial Artery.

The radial artery may be secured by ligature with great ease in any part of its course to the wrist. At the upper third of the arm, the radial artery is covered by the junction of the supinator radii longus and pronator radii teres muscles. To expose it at this part, a line may be drawn from the middle of the bend of the arm to the thumb, which will indicate its course; or the supinator radii longus being put into action, an incision is to be made from the bend of the arm obliquely outwards along its ulnar edge, to the extent of three inches, avoiding the median vein, but dividing the integuments and the fascia. The supinator muscle is then to be gently separated from the pronator radii teres by the point of the knife or by its handle, and the artery will be felt covered by the deep-seated fascia; on the division of which, it will be seen with its venæ comites lying on some adipose membrane, and on some branches of the musculo-spiral nerve, which separate it from the tendon of the biceps, which are to be carefully avoided. The musculo-spiral nerve itself lies nearer the radius, which renders it advisable to pass the aneurismal needle from that side.

In the middle third of the fore-arm, the inner edge of the supinator radii longus marks the line of the incision, which should be to the extent of three inches. The fascia being divided, the supinator longus is to be separated from the flexor carpi radialis, and on the division of the deep fascia, the artery will be found passing with its venæ comites over the insertion of the pronator radii teres, and the radial origin of the flexor digitorum sublimis. The musculo-spiral nerve lies close to the radial side of the artery.

Near the wrist, the radial artery may be tied with great facility. Make an incision two inches and a half long on the radial side of the tendon of the flexor carpi radialis, which becomes prominent on bending the wrist; the superficial and deep fascia are to be divided, when the artery and its veins will be exposed; the nerve has not accompanied the artery to this part, where it lies, first on the flexor pollicis longus, then on the pronator quadratus, and lastly, in crossing round to the back of the hand, on the radius alone.

The radial artery, on reaching the base of the first bone of the thumb on the back of the hand, lies close to it and under the three extensor tendons of the thumb. It then dips down between the first bone of it and the metacarpal bone of the fore-finger, and enters into the palm of the hand, to form the deep-seated palmar arch; sometimes passing behind the abductor indicis and adductor pollicis muscles, sometimes perforating them. The treatment of wounded arteries in the hand is described in the 7th lecture.

THE END.

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